MECHANICAL ENGINEERING

August 1956

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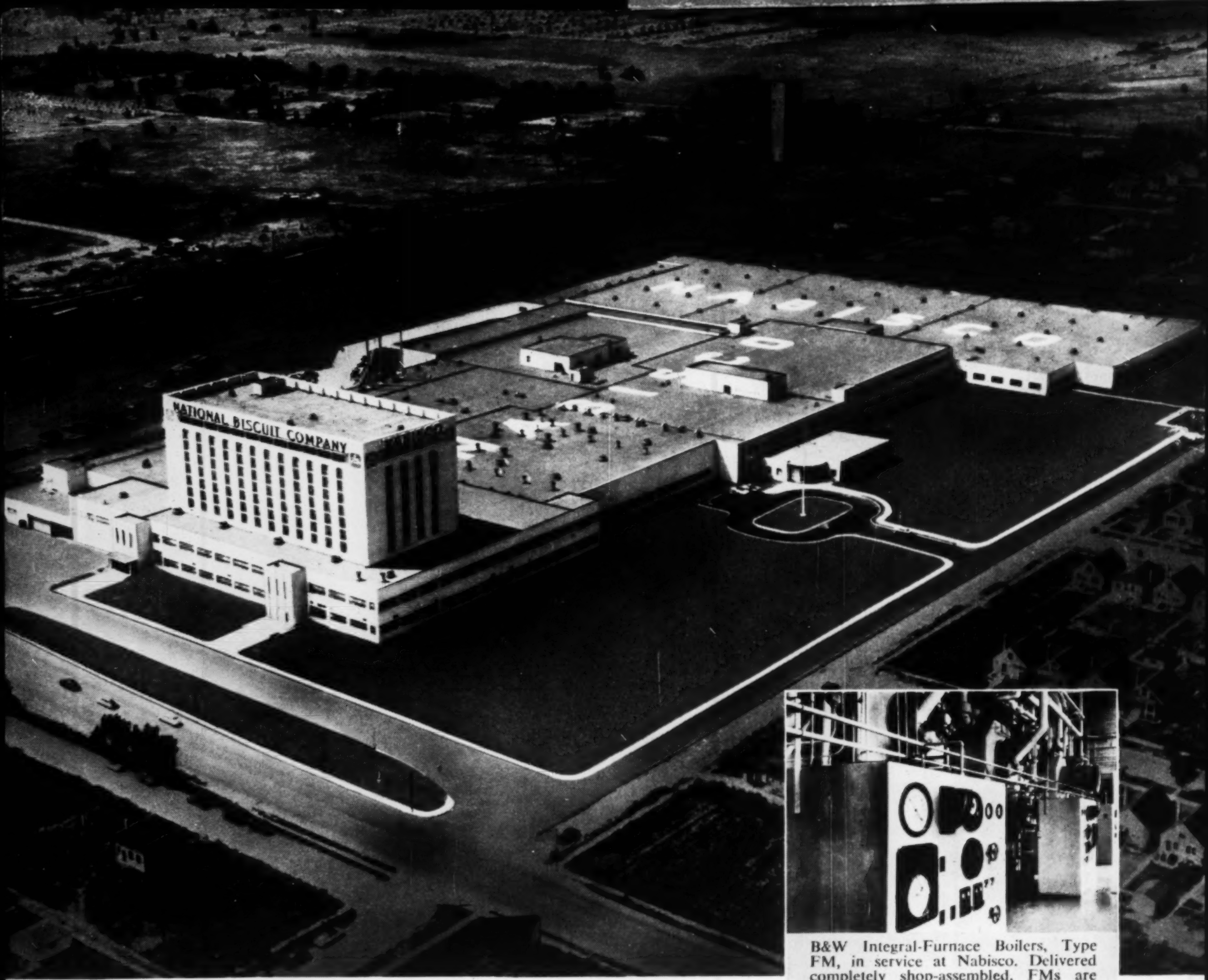


B&W Integral-Furnace Boilers, Type FM, in service at Nabisco. Delivered completely shop-assembled, FMs are ready to position, connect to services, and place in operation.

STEAM AND THE WORLD'S LARGEST BAKERY

This new boiler plant at Nabisco's huge Chicago bakery was planned to provide, efficiently and economically, the steam that the bakery must have on tap at all times for heat, hot water and various processing operations.

Because the reliability, efficiency and economy of its steam source are so vital to this world-famous company—as they probably are to your own—the National Biscuit Company selected B&W Boilers.

Think a moment of *your* company's use of steam—and its cost. Take a fast turn around *your* boiler plant. Spend a little time chatting—perhaps quite profitably—with *your* engineers. Get the facts on *your* company's invested steam dollars in relation to the return you're getting. If the facts add up to problems, B&W engineers will be glad to discuss them with you and your consulting engineers.

When you choose a B&W Boiler, you choose long-range performance. And isn't that what you really want? Not the boiler but its end product, the steam, and the assurance of an efficient, dependable, economical steam source. The service records of thousands of B&W Boilers, in thousands of large, small and medium sized industrial and utility plants, supply that assurance.

The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y

BABCOCK & WILCOX

B&W

BOILER DIVISION

N-213

FACTS

about

NEW DEPARTURE
BALL BEARINGS

EXPERIENCE...

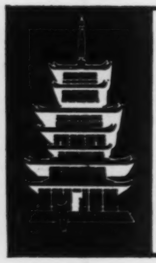
FOUNDATION OF OUTSTANDING QUALITY

● In manufacturing highly specialized precision products, such as New Departure ball bearings, there is no short cut to the knowledge and skill gained by long experience. The superiority of the methods, materials and the products resulting from New Departure's sixty years of manufacturing experience is recognized wherever precision ball bearings are used.

BALL BEARINGS MAKE GOOD MACHINES BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

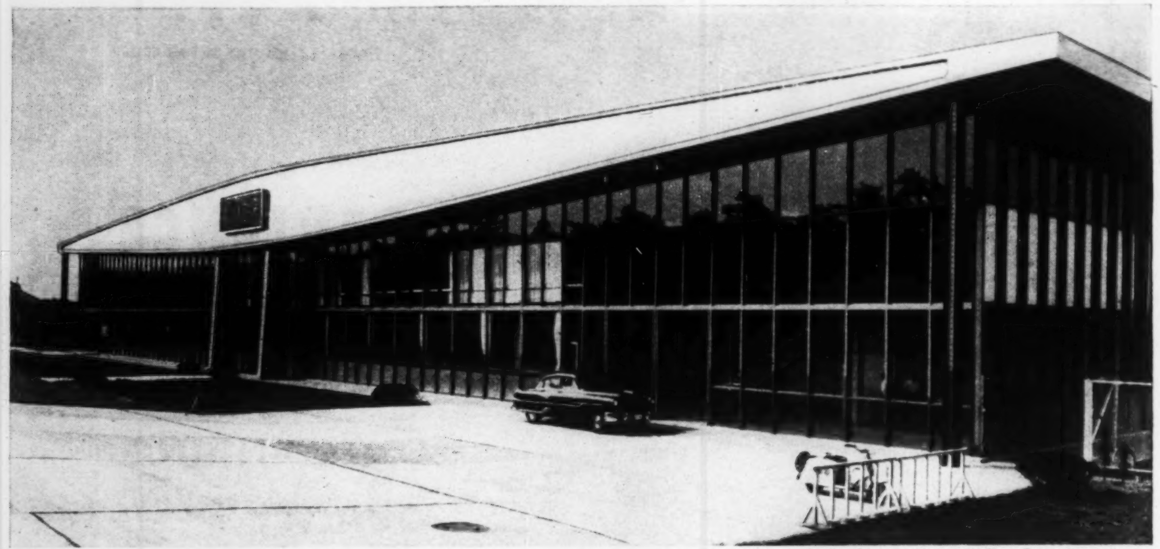
MECHANICAL ENGINEERING, August, 1956, Vol. 78, No. 8. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members $3.50 annually, single copy 50¢; to nonmembers $7.00 annually, single copy 75¢. Add $1.50 postage to all countries outside the United States, Canada, and the Pan-American Union. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.



徐行

EAST MAY BE EAST . . . WEST MAY BE WEST . . .

but *"Cruising Speed"* boiler operation is best . . . *anywhere*



Gakkō Tosho Printing Company, Hara-machi Plant, Tokyo, Japan
Architect: Mr. H. Kishida and Mr. K. Tange, Tokyo, Japan
Engineer: Mr. K. Kawai, Toyohashi, Japan
Heating Contractor: Matsuhisa Industrial Company, Numazu, Japan

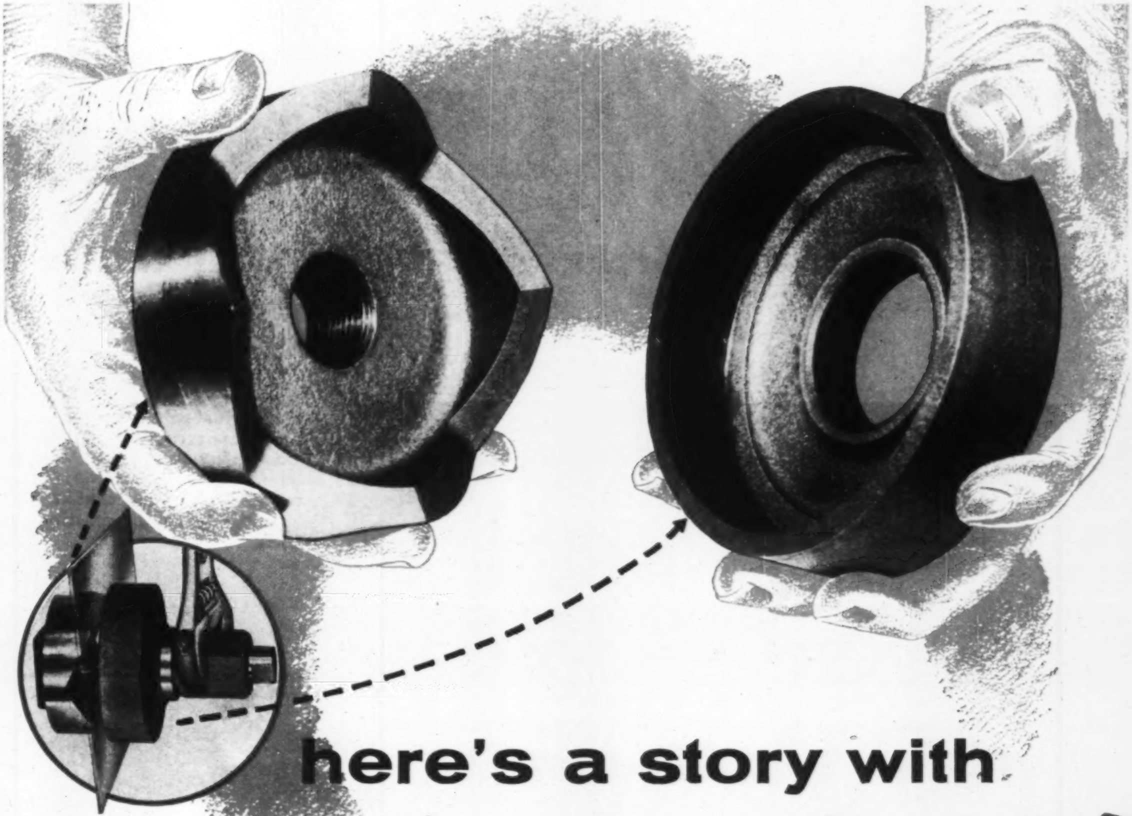
In Far Away Tokyo, Kewanee Boilers Were Selected by Gakkō Tosho Company Because They Provide Reserve Power to Meet Fluctuating Needs. No matter how you say it, in English or Japanese, "cruising speed" boiler operation adds up to the same thing in any language . . . higher efficiency, lower fuel cost, lower maintenance, less wear and tear, longer boiler life. And that's what management at Gakkō Tosho Company wanted in their modern Tokyo printing plant. So they selected Kewanee Reserve Plus Rated Boilers. Here they were assured reserve power to automatically supply steam quickly to operate automatic printing equipment. Reserve power in boilers means "cruising speed" operation . . . dependability . . . with enough power always on tap faster, surer. It means boilers rated on nominal capacity. Boilers rated on maximum capacity run at constant top speed, pile up maintenance and fuel costs—cut boiler life. Next time, choose Kewanee Boilers. Just call for the Kewanee man—in English, Japanese or Sanskrit—and he'll come running to serve you. KEWANEE BOILER DIVISION of AMERICAN-STANDARD, 101 Franklin Street, Kewanee, Illinois

Here is a Kewanee-Iron Fireman Boiler-Burner Unit which assures 'round the clock "cruising speed" operation at the Gakkō Tosho plant.

KEWANEE
reserve plus rated

KEWANEE BOILERS

You can depend on Kewanee engineering



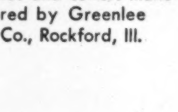
This is one of many knockout punches and cutters manufactured by Greenlee Tool Co., Rockford, Ill.

here's a story with a Knockout Punch!

A Tool Manufacturer Made Drastic Reduction in Production Costs by Using a Copperweld Leaded Alloy

Knockout punches involve turning, drilling, milling and grinding. When the Greenlee Tool Co. switched to a leaded alloy their spindle RPM increased 30%, their tool feed from .005″ IPR to .009″ IPR—ID hogging could now be done with only one tool. Tools lasted nearly 10 times as long using leaded alloy. This is another case of cutting production cost by using steel with "built-in productivity."

Freer feeds and speeds and longer tool life can be yours if you switch to Copperweld Leaded Alloys.



For further details, write for free booklet, "Lead Treated Steels"

ARISTOLOY STEELS

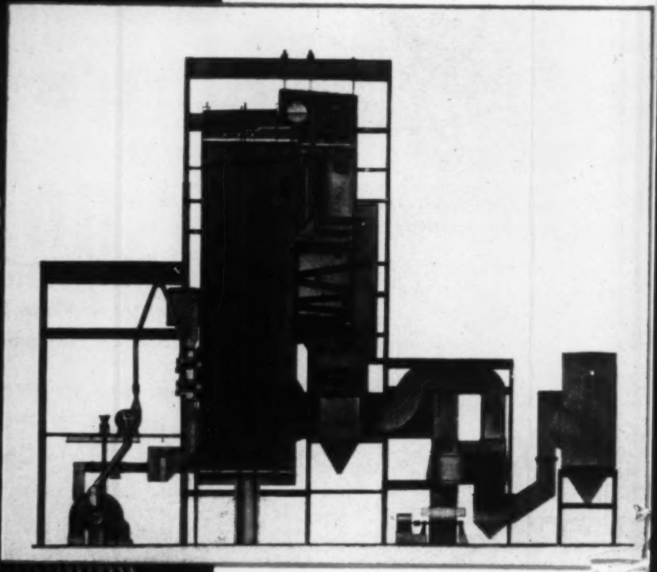
COPPERWELD STEEL COMPANY • STEEL DIVISION • WARREN, OHIO
EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N. Y.

Second "outdoor type" FW steam

LOW LOAD FACTOR

installed at new

Prefabricated at the job site, panel construction of furnace side-waterwalls, radiant superheater and division waterwall made possible significant savings in steam generator construction costs.



Cross-section of Martins Creek No. 2 steam generator, designed for continuous rated capacity of 1,200,000 lbs/hr at 1325 psig normal, 955F. Divided furnace, combination radiant and convection superheater, two continuous loop economizers, weatherproofed outdoor type.

generator, designed for and QUICK START-UP

Martins Creek Steam Electric Station

Built for "below zero" winter conditions, No. 2 unit raises capability of this modern steam generating plant of Pennsylvania Power & Light Company to 320,000 kw.

UNLIKE most new steam generators that are installed for base load operation, with peak loads being carried on older, less efficient units, the new No. 2 Foster Wheeler steam generator at Martins Creek is intended at the beginning to operate at only 20 to 40 per cent capacity.

Like the No. 1 FW steam generator at this station, it is a peak load unit. It has the requisite control facilities so that it quickly can help meet the early morning demand present in the PP&L system. For these heavy load periods, it provides the desired additional capacity economically, at minimum total annual cost — the major portion of the power being provided by other stations of the system where the delivered fuel cost is appreciably lower.

The eleventh FW unit now serving the Pennsylvania Power & Light Company, this Martins Creek steam generator has an 8-hour-peak capacity of 1,300,000 lbs/hr at 1325 psig, 955F at the superheater outlet. Final steam temperature is held constant at all loads from 325,000 lb per hr to full load. Of the single drum, nonreheat type, it supplies steam to a turbine generator with a nameplate rating of 132,500 kw. Two Foster Wheeler ball mill pulverizers furnish bituminous coal to twelve 30-inch FW intervane burners.

View looking south showing Pennsylvania Power & Light Company's new Martins Creek Steam Electric Station.

Backed by more than 50 years' experience in power plant equipment pioneering, steam generators by Foster Wheeler assure efficient, dependable performance at low overall cost. Whatever your requirements, it will pay you to consult us. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

U.S.P. PATENTED STAINLESS STEEL PROCESS

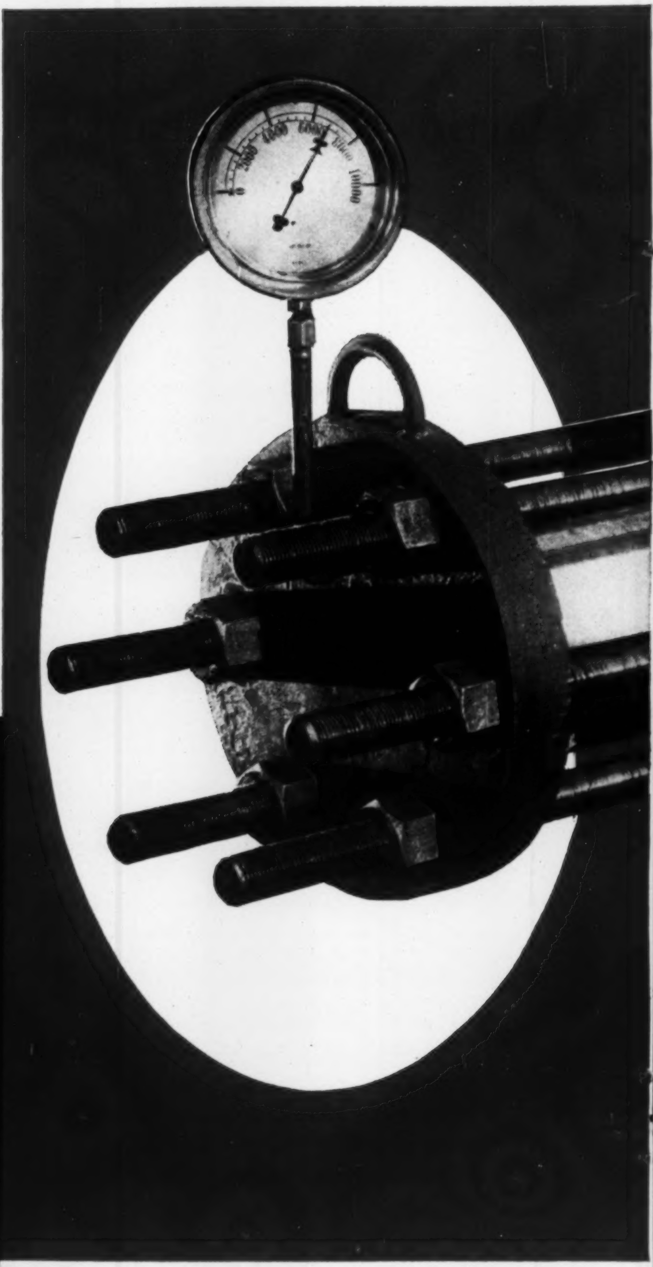
Centrifugally cast stainless steel pipe passes rigid specifications . . . including severe hydrostatic pressure test.

The men who design today's petrochemical plants, refineries or Atomic power plants are confronted with piping problems involving temperatures, pressures and corrosive conditions which only a few years ago would have been called impractical, if not impossible.

U. S. Pipe's Steel & Tubes Division recently completed a piping requirement for 700 feet of Type 316 Extra Low Carbon, columbium-bearing stainless for a large petrochemical plant, which is typical of the job metal mold centrifugally cast pipe is doing today under a patented manufacturing process with rigid Quality Control.

U. S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses — in large or small quantities.

Write and outline your stainless piping problems. We may be able to help.



Note these exacting specifications on 316 Cb ELC Stainless Steel Pipe demanded by one of nation's leading oil companies:

Material Requirements: Pipe shall conform to ASTM Specification A-362-52T.

Chemical Analysis: Modified AISI Type 316 Cb (ELC), with *one percent* spread on chrome and nickel.

Finish: Each pipe to be turned, bored and faced to surface finish of 125 micro inch or better. O.D. tolerance plus 1/16" minus 0"; I.D. tolerance plus 0" minus 1/32". Pipe size: 12" O.D. x 1.17" wall.

Mechanical Tests: Tensile Tests — 2 tests required on each pipe after heat treatment; one at room temperature, one at 700° F.

Inspection Requirements

1. Etching test on sections cut from each end of pipe.
2. Radiographic Inspection — Required complete circumferential coverage of at least an 8" wide section at each end of each pipe in accordance with ASTM Specification E71-52.
3. Fluid Penetrant — Entire O.D. and I.D. surface each piece.

Heat Treatment: Heat for 4 hours at 2100° F.–2150° F., water quench, follow by 5 hours at 1500° F.–1600° F. Cool in still air.

Hydrostatic Test: Each length tested to stress of either 90% of the minimum cold yield strength or a maximum pressure of 6800 psi — whichever is lower.

UPPER: Hydrostatic test rig used to qualify each length of pipe.

LOWER: Turned and bored stainless pipe is dimensionally accurate and furnished with superior I.D. surfaces.

MEETS RIGID PIPING REQUIREMENTS

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—6" to 50"

Wall Thickness—⅜" and up

Length—Up to 16'

Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.

UNITED STATES PIPE & FOUNDRY CO.

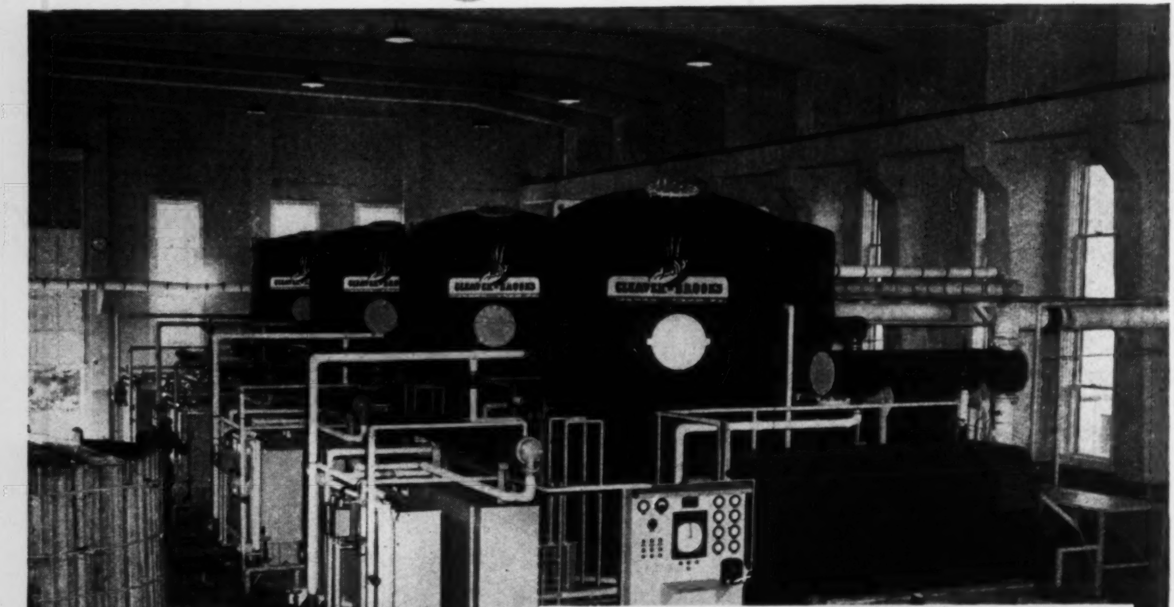
Steel and Tubes Division

STEEL AND TUBES DIVISION USP

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, COLUMBUS, DETROIT, PITTSBURGH, HARTFORD, BURLINGTON

World's



BATTERY OF CLEAVER-BROOKS EVAPORATORS IN ACTION—Revere Silicon Bronze was chosen for these evaporators and their component parts because of its high corrosion resistance and non-contamination properties, great strength and weldability. All of the components, as well as the 4 evaporator shells, are made of Revere Silicon Bronze Alloy No. 420.

ONE OF THE 4 EVAPORATOR SHELLS made of Revere Silicon Bronze, fabricated and installed by CLEAVER-BROOKS MFG. CORP., Waukesha, Wisconsin.

EIGHT TUBE SHEETS LIKE THESE were used in the Bermuda installation . . . 2 per evaporator. Each tube sheet, made of Revere Silicon Bronze, is 86" in diameter, 1¼" thick and weighed approximately 1,360 lbs. after drilling.

Largest

VAPOR-COMPRESSION SEA WATER DISTILLATION PLANT

Made and installed by CLEAVER-BROOKS *. . . Vital distillation units fabricated from* REVERE SILICON BRONZE

This plant installed at the Kindley Air Force Base in Bermuda has a total daily capacity of 200,000 gallons and eliminates the dependence of the Base on rainfall or shipment of water by tankers.

Distilled water is produced in the ratio of 300 lbs. to each pound of Diesel fuel. Total costs are estimated at $1.25 per thousand gallons of distilled water. Nearly every component part made by Cleaver-Brooks is about twice the size of its largest previous counterpart. For example, the evaporators are 16½ feet high. Each, with its component parts, weighs approximately 40,000 lbs., the empty Revere Silicon Bronze shell alone accounting for 28,000 lbs.

There is an interesting story behind the development and manufacture of this equipment. The four huge pressure vessels had to be fabricated of Revere Silicon Bronze Alloy No. 420. Knowing Revere's wide experience in welding copper-base alloys, Cleaver-Brooks called in a Technical Advisor, and gave him a complete set of blueprints of the vessels, with a request for suggestions regarding joint design and welding techniques. He in turn consulted the Welding Section of the Revere Research Department. Their recommendations were adopted, and the customer reported that the original estimate of welding time had been cut considerably, reducing production costs correspondingly.

The Revere Technical Advisory Service is glad to collaborate on problems involving the specification and fabrication of copper and copper-base alloys, and aluminum alloys. See the nearest Revere Sales Office.

REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

COPPER ★ BRASS 18 01 ★ REVERE ★ ALUMINUM

THE STEAM SEPARATORS are identified by their conical tops and directional vanes. They are of the cyclone type, which is a patented feature of CLEAVER-BROOKS evaporators, and remove entrained water from the steam, thus preventing contamination of the fresh water coming from this unit. The result is an extremely high purity of the fresh water product.

The rectangular objects at rear of photograph are the "Downcomers" which bring water down from the top of the steam separator. The tubes in left foreground are "Hotwells," which receive the distilled water discharge from the evaporator shell.

ONE OF A SERIES OF INFORMATIVE MESSAGES FROM HYATT . . .

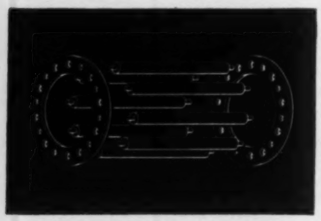
Cylindrical Roller Bearing Retainers . . .

The seven basic types in current use . . . their influence on bearing cost and performance . . . why one type is best suited to your individual design requirements

Most cylindrical roller bearings consist of an inner race, an outer race, a complement of rollers, and a cage or separator which locates and guides the rollers. There are significant differences in the design and construction of these roller retainers. (The word "*retainer*" is used to designate both a cage, which retains the rollers, and a *separator* which only spaces the rollers.) Some retainers are simple and economical, well adapted for volume production, and designed for use where price is a primary consideration. Others are more costly to make but are designed for improved roller guidance, to insure cooler or smoother operation, or to provide longer life in heavy duty service.

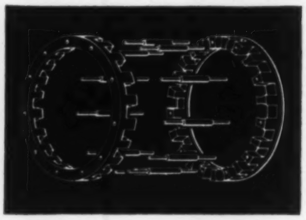
Beginning with the most elementary, here are the seven basic types of cylindrical roller bearing retainers in current use, with a brief outline of their construction and characteristics:

1. TRUNNIONED ROLLER CAGE



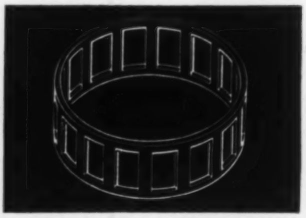
The trunnioned roller cage is used for bearings of very thin annulus, where the rollers must be small in diameter, closely spaced, and relatively long. The end rings are economical hardened steel stampings, into which the trunnioned rollers are inserted. The bars which connect the end rings are riveted to the rings at assembly so that the rollers and cage form an integral, non-separable unit. Thus, outer or inner races can be omitted if desired, with rollers operating directly on a suitably hardened shaft or housing bore. This cage is an economical design for volume production and possesses excellent operating characteristics for a wide range of applications.

2. POCKETED END RING CAGE



The pocketed end ring cage is restricted to fairly large bore bearings with relatively long rollers. The end rings are bronze. The steel connecting bars are riveted into the end rings and the rollers operate in drilled pockets which guide them accurately. The construction has less tendency to twist or rack, and operates with less end friction because the outside faces of the bronze end rings are smooth uninterrupted surfaces. This type is known as a roller-riding cage, and makes no contact with the bearing races. It can be produced economically in small lots and since it is non-separable, bearing races can be omitted if desired. The characteristics of the pocketed end ring cage make it particularly desirable for applications where long life and heavy-duty service are required.

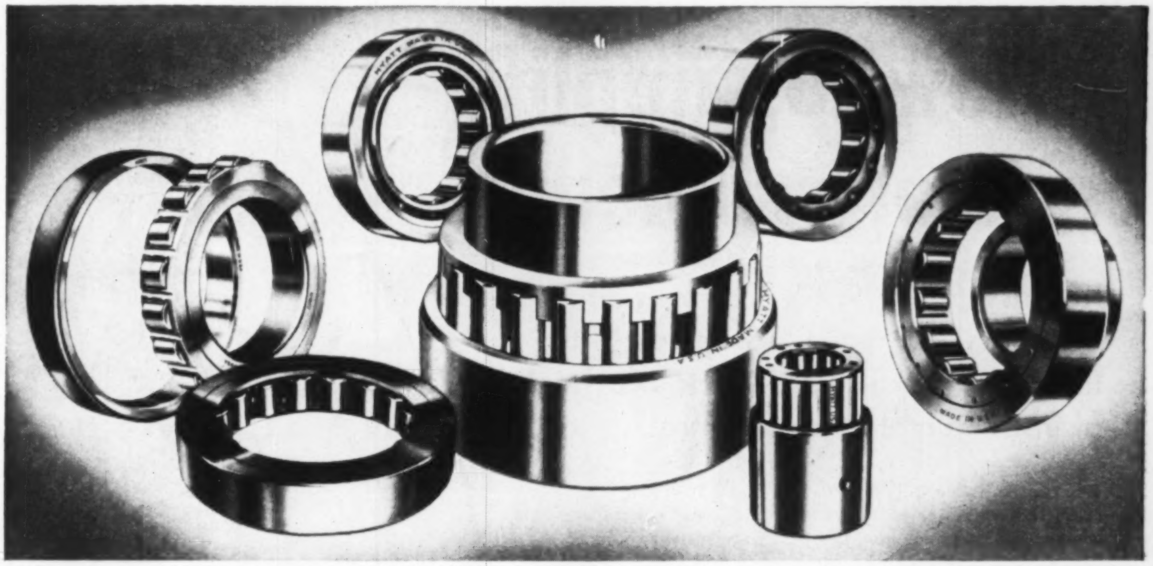
3. STAMPED STEEL SEPARATOR

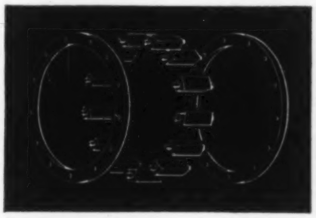


The stamped steel separator does not retain the rollers by itself, but merely separates them. It is a one-piece steel stamping with the separating bars coined to conform to the roller contour, and rides the rollers below their pitch line. Rollers are guided by the race flanges and snap rings, in conjunction with the cage bars. The simple, open design of this separator insures large grease capacity and good lubricant circulation, rendering it relatively insensitive to dirt. Since the separator is retained axially by the roller ends, there is no external requirement for axial location. The stamped steel separator is usable throughout a wide range of bearing sizes where rollers are relatively short (the Hyatt Hy-load series), and is economical for volume production.

4. FORMED BAR CAGE

The formed bar cage is built up of stamped end rings and bars formed to the roller contour. The end rings and bars are riveted together at assembly, making the race and roller assembly a non-separable unit. This cage is used on Hy-load bearings, with double-flanged inner or outer races. This

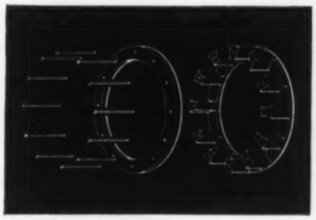




design insures quiet operation, better roller guidance, and provides a smooth contact surface between bars and rollers. This is a roller-riding design requiring no race contact in operation and is well adapted for volume production.

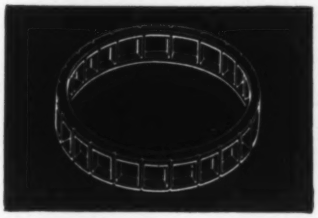
5. DRILLED POCKET CAGE

To construct this type, a bronze cylinder is drilled and reamed to form pockets in which the rollers operate. After the rollers are inserted, a flat end ring is riveted in place so that the rollers are permanently retained in the cage. This design provides extremely close control of the rollers in operation and prevents skewing which would impair both the thrust and radial capacity of the bearing. This is another roller-riding cage comprising a non-separable unit suitable for operation with inner or outer races omitted. The design insures superior performance and is used in applications requiring bearings of better than commercial quality.



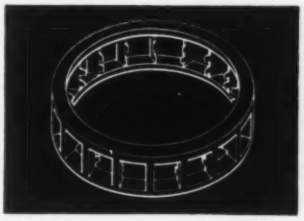
6. SEPARABLE BROACHED POCKET CAGE

This type is used only on the finest-quality bearings where performance is more important than price. It is made of one integral bronze cylinder, with pockets broached for maximum uniformity. This is the preferred type for the finest high-speed precision bearings because it insures minimum friction between rollers and separator, and allows better oil circulation for cooling at high speeds. Moreover, there are no thermal differences in this monolithic construction; the entire unit heats and cools uniformly. The separable feature offers the further advantage of roller removal for inspection of the race operating surfaces.



7. NON-SEPARABLE BROACHED POCKET CAGE

Similar in construction to the above, this design offers all the same inherent operating advantages. It is used in bearings where installation must be "blind," requiring rollers to be retained with the inner or outer race. Controlled roller drop is provided by deforming the connecting bars at assembly after the rollers are in place in the cage. This insures proper retainment but has the disadvantage that the bearing cannot be taken apart for inspection.



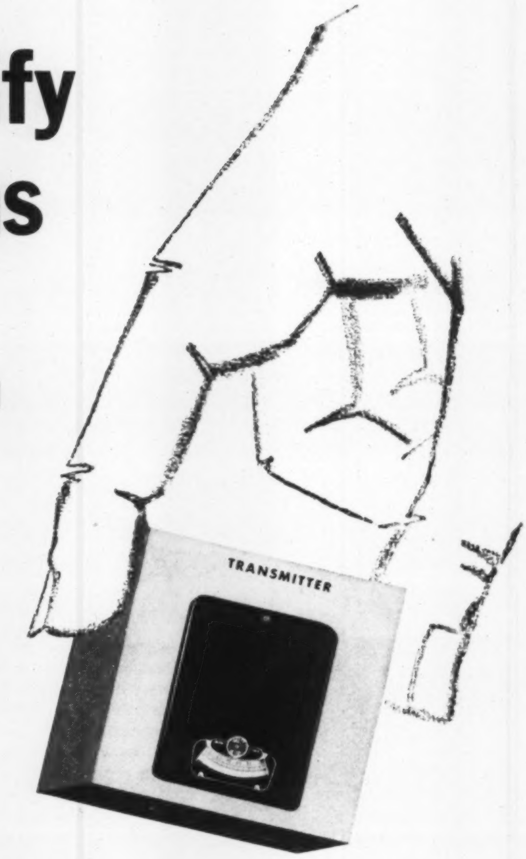
HYATT MANUFACTURES ALL SEVEN TYPES of cylindrical roller bearing retainers described above—each the finest of its type. You will find more details in HYATT General Catalog No. 150, or your nearby HYATT Sales engineer will be glad to help you choose the type best suited to your individual design requirements. Remember, HYATT is America's *first* and *foremost* maker of cylindrical roller bearings. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

GM
GENERAL MOTORS

HYATT
ROLLER BEARINGS

How to simplify control problems

Keep systems flexible, carry small inventory, cut maintenance cost with the **Bailey Building Block Method** of instrumentation and control.



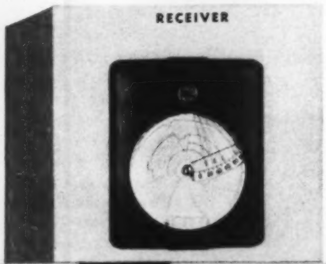
What is the Bailey Building Block Method? It's using standardized Bailey measuring, transmitting, and controlling components and combining them into any system you need. Components can be added as needed . . . removed and reused elsewhere . . . recombined into another system when the need changes. It's flexibility plus!

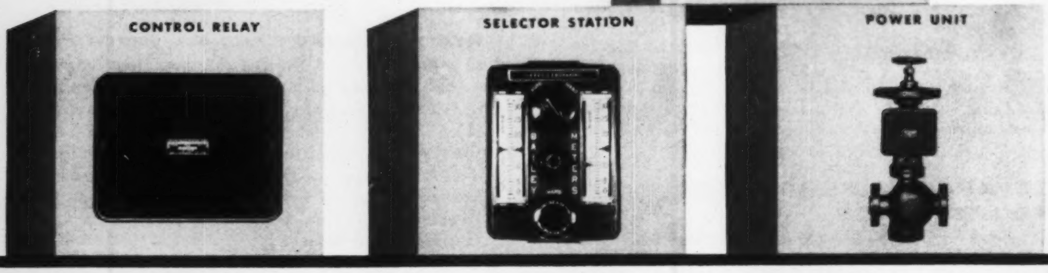
It's all based on the simple fact that a Bailey instrument or control component doesn't care if the measured variable is steam flow, tank level, or tower temperature, to pick just three examples. System components—transmitters, receivers, relays, selector stations, power units—are standardized for multi-purpose use.

A spare component can be used in any one of many systems. Gone are delays waiting for shipments of special parts. Gone are large inventories of spares and parts. Simplified is the training of men for maintenance.

There are many exclusive features and advantages of the individual components used in the Bailey Building Block Method. And there's much more to the Building Block story itself.

For further details, call our local district office or write us at Cleveland. Our engineers will be glad to prove how the Building Block approach will save you money and simplify your instrument and control problems.





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BAILEY
BUILDING
BLOCK
METHOD

BAILEY METER COMPANY
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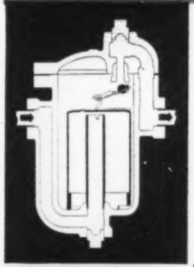
In Canada—Bailey Meter Company Limited, Montreal

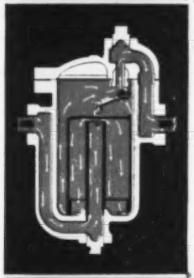
RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

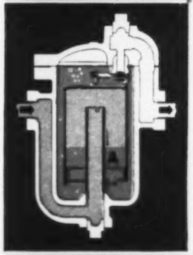
How Armstrong Trap Design Improves Plant Efficiency . . .



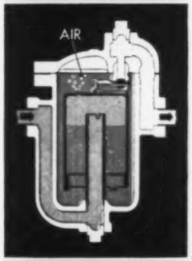
1 When trap is first installed, the inverted bucket is down and the valve is wide open. The large clearance between valve and seat minimizes restriction to condensate flow, contributing to large capacity.



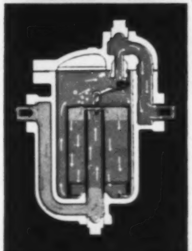
2 When steam is turned on, note how condensate (solid color) flows down between bucket and trap body, then up and out through orifice. Dirt is held in suspension and washed out when valve opens.



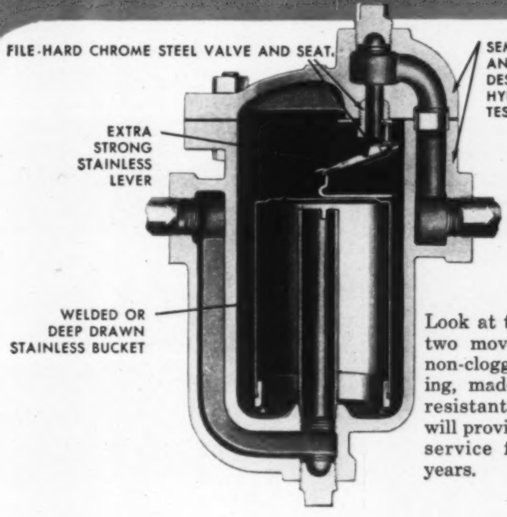
3 When steam reaching trap displaces less than ⅔ of the water in the bucket, it floats, closing the valve. Generous safety margin (dimension A) insures that steam will never reach trap orifice.



4 When more condensate enters trap, the bucket loses buoyancy and pulls on valve lever. (Note how incoming air passes through bucket vent and collects at top of trap, awaiting discharge.)



5 When weight of bucket times leverage overcomes pressure on valve, trap opens, creating momentary pressure drop that "pumps" condensate and non-condensibles from unit being drained.


FILE-HARD CHROME STEEL VALVE AND SEAT
EXTRA STRONG STAINLESS LEVER
WELDED OR DEEP DRAWN STAINLESS BUCKET
SEMI-STEEL BODY AND CAP. 250 LBS. DESIGN PRESSURE—HYDROSTATIC TESTED AT 500 LBS.

Look at this trap. Only two moving parts. It's non-clogging, non-sticking, made of corrosion resistant materials. It will provide trouble-free service for years and years.

Time-Tested Inverted Bucket Principle Provides Five Cost-Reducing Benefits:

The modern Armstrong Trap is unsurpassed in these five major contributions to plant operating efficiency:

1. Fast heat-up—thanks to large condensate and air handling capacity. On batch or cycled production, you get maximum output per day.

2. High heat transfer rate—quick opening creates a sudden surge of condensate and air from the unit being drained. This pumping action prevents stratification of incondensibles and insures complete drainage. Laboratory and field tests prove it produces higher heat transfer than is otherwise possible.

3. Low Fuel Consumption—non-productive radiation losses are minimized because condensate is discharged at steam temperature as fast as it accumulates in the trap—you get more production per hour and per unit of fuel. And, there is no steam loss through the trap orifice.

4. Continuity of operation—the trap always opens for condensate; the simple, sturdy, self-cleaning mechanism insures continuous operation between inspections without interruption of processing.

5. Low Maintenance—no trap has ever gained so enviable a record for trouble-free service—ask anyone who has kept records.

Free: Steam Trap Book—
44 helpful pages on trap selection, installation maintenance, physical data and prices. Call your local Armstrong Representative or Distributor, or write:

ARMSTRONG STEAM TRAP BOOK

ARMSTRONG MACHINE WORKS
894 Maple Street • Three Rivers, Michigan

ARMSTRONG *Inverted Bucket* **STEAM TRAPS**

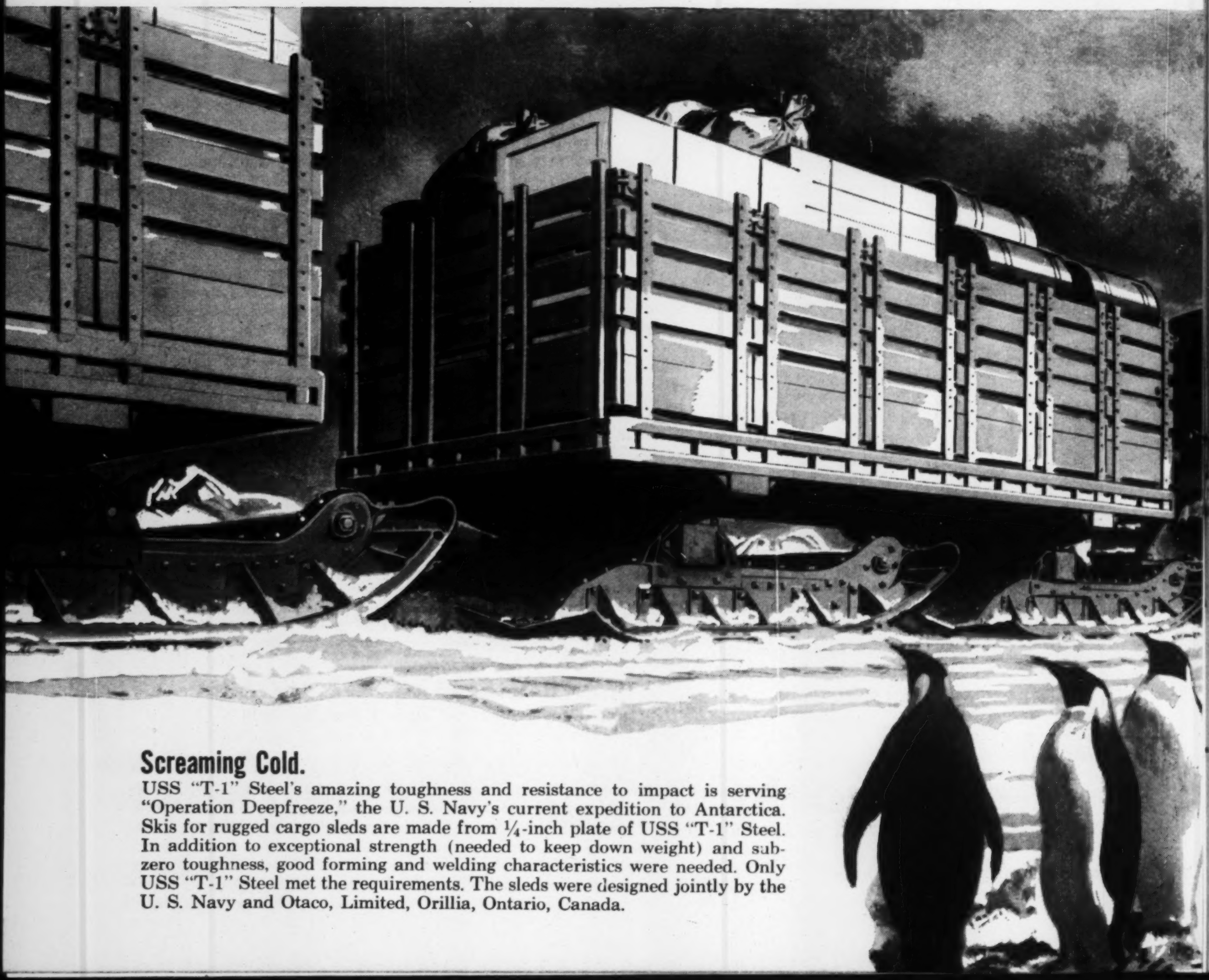
HOW USS "T-1" STEEL IMPROVES

Repair Reduces Downtime.

In this coal stripping operation, time costs more than any other item; and *lost* time, caused by breakage and wear of power shovel parts, was costing far too much. So the owner, Putnam & Greene, Inc., Philipsburg, Pennsylvania, started using USS "T-1" Steel for repair work. As a result, size and weight of parts have been reduced, while durability has been improved substantially. What's more, USS "T-1" Steel's good weldability speeds repair work.

28 Million Pounds of Wet, Abrasive Coal

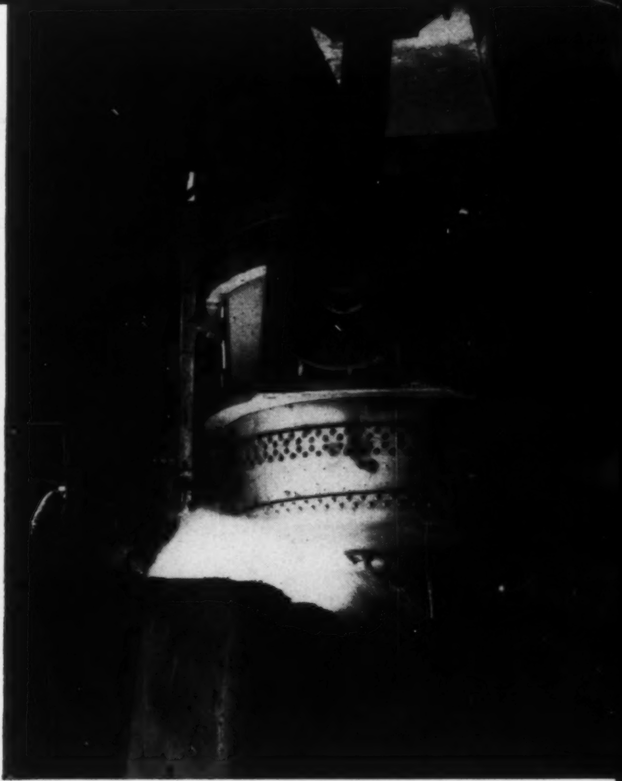
are handled each day at this steam-electric generating station. And USS "T-1" Steel is being used at points of severe wear in coal chutes and hoppers, pulverizer feed pipes and exhaust pipes, and for liners of ash collectors. USS "T-1" Steel's durability under impact and impact abrasion, its great tensile strength and its good weldability are often essential in rugged coal handling equipment. USS "T-1" Steel can add service life and cut repair and maintenance costs.



Screaming Cold.

USS "T-1" Steel's amazing toughness and resistance to impact is serving "Operation Deepfreeze," the U. S. Navy's current expedition to Antarctica. Skis for rugged cargo sleds are made from ¼-inch plate of USS "T-1" Steel. In addition to exceptional strength (needed to keep down weight) and subzero toughness, good forming and welding characteristics were needed. Only USS "T-1" Steel met the requirements. The sleds were designed jointly by the U. S. Navy and Otaco, Limited, Orillia, Ontario, Canada.

THESE PRODUCTS:



Sizzling Hot.

By redesigning with USS "T-1" Steel, crane hooks for 250-ton ladles at U. S. Steel's Edgar Thomson Works were reduced in thickness from 8½ inches to 6 inches. The resulting weight saving of 3 tons permits an increase in actual crane capacity. The ladles, too, were redesigned with USS "T-1" Steel. All told, the weight saved adds 20 net tons to the capacity of each new ladle.

HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,000 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking heavy impact and abuse at sub-zero temperatures. Its excellent weldability can help you cut the cost of fabricating highly stressed parts, and to reduce repair and maintenance expense. Its good creep rupture strength can help you put more durability in equipment that operates at temperatures as high as 900 degrees F.

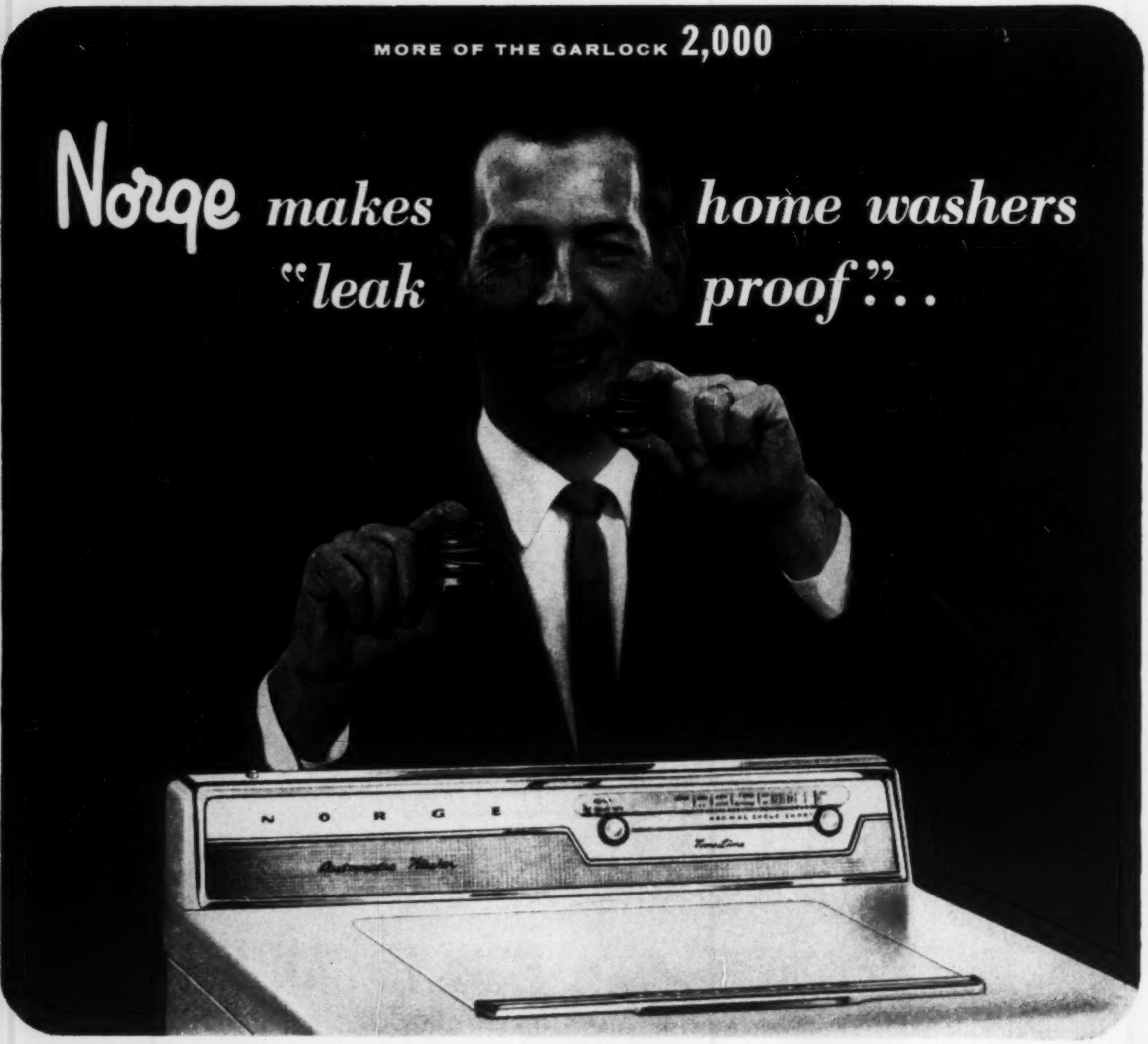
Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Room 5423, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION
WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T1" CONSTRUCTIONAL ALLOY STEEL

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL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Norge makes "leak home washers proof"...
NORGE
Automatic Washer

. . . *with Garlock Mechanical Seals* on agitator and basket shafts. Compact, ready to install, Garlock MECHANIPAK* Seals provide a positive "leak-proof" contact between carefully lapped metal-to-carbon mating surfaces. Wear on shafts is eliminated, and service life is multiplied.

If you have a job that requires volume use of seals or packing, discover for yourself, as Norge has, that everything's right about Garlock MECHANIPAK Seals . . . including the price!

And, remember MECHANIPAK Seals are only part of the famous Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals to meet *all* your needs. It's the only complete line . . . it's one reason you get *unbiased* recommendations from your Garlock representative. Call him today or write for Catalog AD-150.

**Registered Trade Mark*

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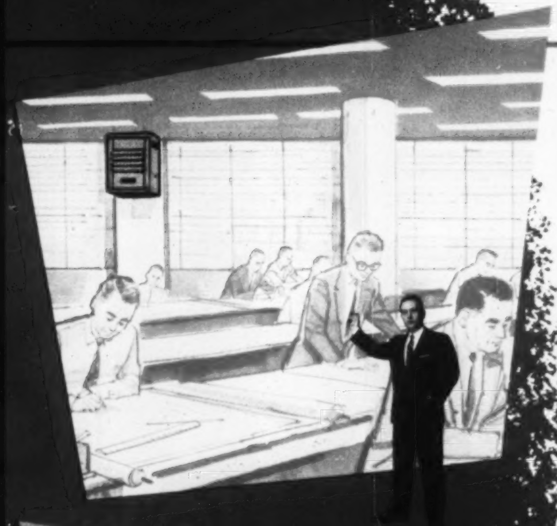
GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

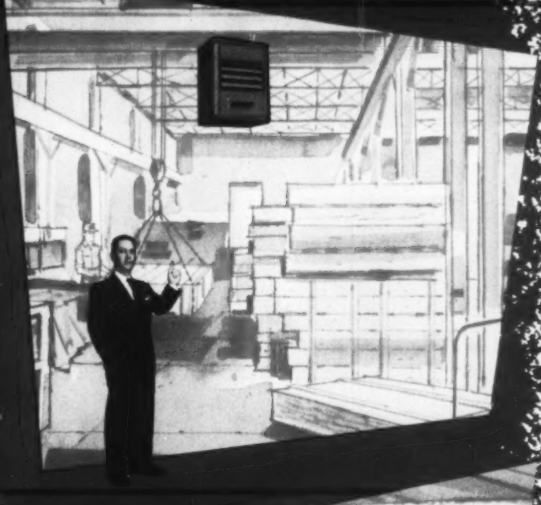
"Let me show you how we solved all our plant heating problems with Reznor Gas Unit Heaters"

REZNOR
Gas Heaters



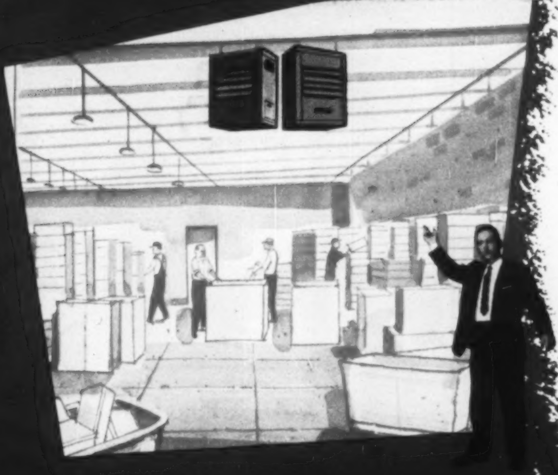
"Our engineers were always complaining about the cold until we installed Reznor heaters in the drafting room"

"Our steam heating system does a good job out in the plant where temperature levels don't need to be as high or as steady, but we've always had trouble keeping office workers comfortable. So we installed these Reznor gas unit heaters in the drafting room. It worked out so well we're using Reznor heat in all office areas now. Reznor heaters are doing a better job for us in these areas because they respond instantly, automatically to the temperature requirements of their immediate surroundings. Reznor suspended units are fine here in the drafting room. In other office areas, where floor space is at less of a premium and appearance more important, we've used Reznor floor models. We even installed them in the executive offices, and they've helped sell management on Reznor heating."



"Rust was eating away our warehouse stocks; these Reznor heaters put a stop to it"

"Rust used to be a serious problem at both ends of our production lines. It attacked our supply of sheet metal. And it caused trouble in the warehouses where we stockpile our finished products. One way or another rust was costing us thousands of dollars a year; we could have afforded to pay plenty to stop it. But we didn't have to! Reznor gas unit heaters proved to be the efficient, economical answer to our rust problems. We installed a few Reznor heaters in our steel warehouse and a few more here in our finished products warehouse, set the thermostats and forgot them. Rust is no longer a problem. The heaters are no problem, either. Operating costs are lower than we had expected, and maintenance costs have been zero."

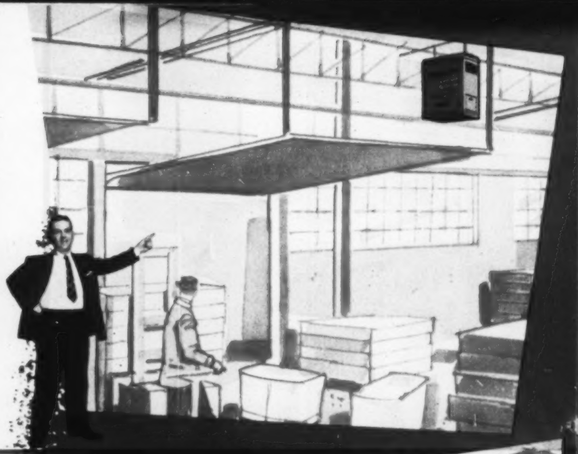


"Our boilers didn't have the extra capacity to handle this plant addition . . . Reznor heaters were the perfect solution"

"When we completed this new plant addition, our boilers weren't able to take the additional heating load. It wasn't going to be economical to add another boiler, or to replace one of our boilers with a boiler of larger capacity. Reznor heaters were the perfect solution for our problem. Eighteen 150,000 BTU Reznor heaters gave us the required capacity and they maintain an even, comfortable temperature throughout the new section of the plant. Installation costs were surprisingly low. Operating cost has been less than that for the same capacity from the steam system, and we've had absolutely no maintenance work to do. When our present boilers need replacement, we'll probably switch the whole plant to Reznor gas unit heating."

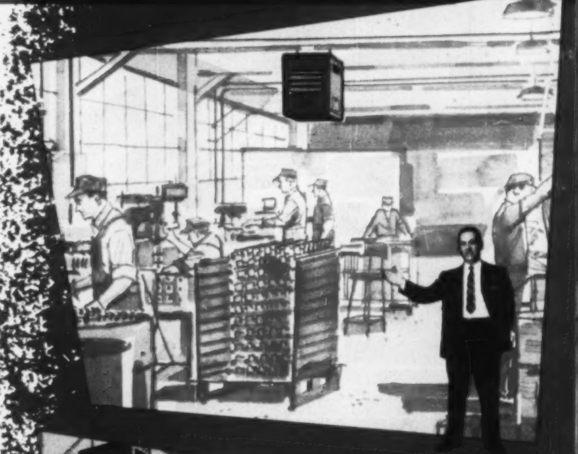
"Heat loss through these shipping room doors was tremendous until Reznor suggested this answer"

"Until these Reznor heaters were installed, our shipping room crew might as well have been working outside during cold weather. Whenever those big doors were open, the cold wind came blasting in, making everybody uncomfortable, unhappy, and inefficient. Reznor gas unit heaters have eliminated all that. Installed so they discharge across the door areas, they lay down a curtain of warm air which keeps winter outside where it belongs. And they operate completely automatically . . . putting out a powerful blast of heat within a few seconds after the doors are open. The lesson we learned here has been applied to eliminate trouble spots in other parts of the plant, too. It's paid off in better health, morale and efficiency among our workers."



"We saved $120,000 here by installing Reznor heaters instead of replacing a worn-out boiler"

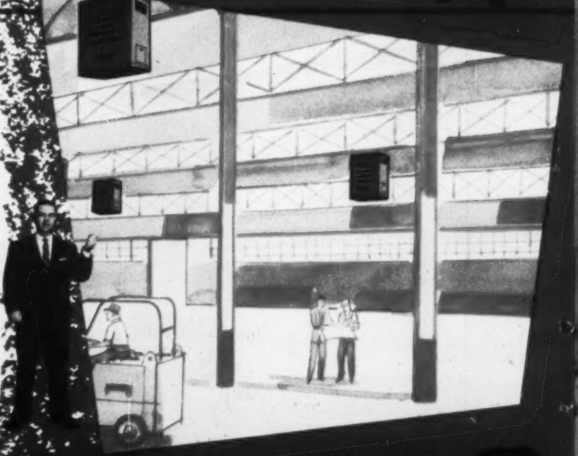
"When the old heating boiler at this plant gave out, we were told it would cost $150,000 to replace it. Then we discovered we could have a Reznor heating system for approximately one-fifth of that cost. It's a big building . . . 165,000 square feet of space to be heated. It took 64 Reznor heaters and over◀20,000 feet of pipe to do the job, but we saved $120,000 on equipment and original installation. And we're saving a lot more on operation and maintenance costs. For example, we saved $15,000 a year in salaries by eliminating the four men formerly needed to operate the boiler room. And the plant is more comfortably heated than it ever was before."



"We select Reznor heaters to do the whole job at our new East St. Louis plant because . . ."

"All the experience we've had with Reznor in our other plants has been 100% good. And when we added up the pros and cons on the heating system for this new plant, they came out heavily in favor of Reznor again. Here's some of the reasons why: Lower original equipment costs. Much lower installation costs. No valuable floor space required for any heating equipment, no space required for fuel storage. Low fuel costs. No maintenance problems — maintenance is mostly a matter of one cleaning a year.

"Dollars and cents clinched the job for Reznor, but there are other advantages, too. Worker comfort is important to us, and everywhere we've tried it, Reznor heat has been the most comfortable heat we've ever had. Reznor contributes to worker comfort even during hot weather, because those big powerful fans can be turned on to provide cooling air circulation."



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THE WORLD'S LARGEST SELLING GAS UNIT **HEATERS**

"We found that only gas unit heating offers all these advantages . . ."

- LOW EQUIPMENT COST
- LOW INSTALLATION COSTS
- COMPLETE ADAPTABILITY TO FUTURE CONSTRUCTION
- LOW OPERATING COSTS
- NO MAINTENANCE PROBLEMS
- INSTANT RESPONSE TO EVERY CHANGE IN TEMPERATURE
- WASTE NO FLOOR SPACE
- EXTRA HEAT FOR TROUBLE SPOTS

For more information mail the coupon at left or call your nearby Reznor distributor. He's listed under "Heaters-Unit" in the yellow pages of your telephone directory.

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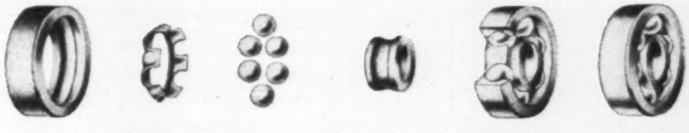
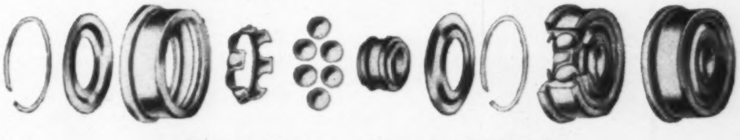
ENGINEERING BULLETIN
ON MICRO-BEARINGS
Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH 1, NEW HAMPSHIRE

Subject: FACTORS TO CONSIDER IN MINIATURE BEARING APPLICATION



Retainer Bearing — Exploded and Assembled Views

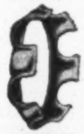


Retainer Bearing — Flanged and Shielded

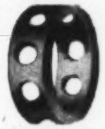
TYPES OF BEARING

The Retainer Bearing fitted with the one-piece crown retainer is well suited for the great majority of instrument applications. Even ball spacing produces good performance at low-moderate speeds, and it can also handle radial or thrust loads. Improved fabricating techniques result in crown retainers being specified for low-torque requirements.

Phenolic Retainers machined from phenolic plastic allow higher speeds and also provide some retention of lubricant. This retainer is used with angular contact bearings where one land is ground away from the inner or outer ring to permit bearing assembly. Such a design permits thrust *only* in the direction of the side having the full land.



CROWN



PHENOLIC

The Full Bearing has a full complement of balls. Filling notches are ground on one side of each ring to allow assembly. This type is steadily being replaced by retainer bearings which cost less to manufacture and assemble. It has an advantage for certain applications requiring maximum radial load capacity, but is unable to handle thrust loads because of possible interference between the balls and filling notches. Contact between the balls creates friction which makes the full bearing unsuitable for low torque or high speed applications.

MATERIALS

Stainless Steel's anti-corrosive properties have made it first choice for bearings used in precision instruments, and it has become one of the standard materials for this purpose. It can be ground and finished to a high degree of precision.

Chrome Steel should only be specified when bearings must operate at critical limits of capacity, a condition not often encountered in instruments. It has a somewhat higher load rating than stainless steel but is subject to rapid corrosion if not protected during handling and use.

Beryllium Copper should be restricted to applications which definitely require non-magnetic properties in the bearings. All components of the bearing are fabricated from this material. If non-magnetic properties are not required, stainless steel is a better selection.

LOAD RATINGS

A miniature bearing is seldom operated at or near its rated load capacity. However, the designer must have sufficient information to assure intelligent selection. The load ratings presented in the New Hampshire Ball Bearings, Inc. catalog tables are based on standards established by the AFBMA after extensive studies and tests.

Dynamic load ratings apply to bearings that are rotating. Time-consuming calculations can be avoided by making use of the C factor shown in our catalog.

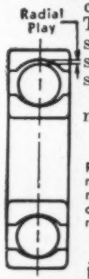
Static load ratings apply to bearings at rest. Since this exists in relatively few cases, static load rating is not usually given much emphasis. Formulae have been developed, however, and the need for this information is increasing, — primarily for units subjected to shock loading.

RADIAL AND AXIAL PLAY

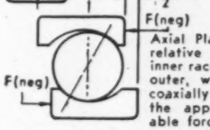
Radial play is the displacement of one ring with respect to the other along the *diameter* of the bearing.

It is important in the successful application of precision bearings and should be specified in orders. A range of .0002" to .0005" is satisfactory for most applications but tighter or looser clearances may be required. The minimum clearance should be .0001" and the total spread from min. to max. should be at least .0002".

Axial play is the displacement of one ring with respect to the other along the bearing axis. It is specified only when axial positioning of the shaft must be held within certain limits. Radial and axial play are mutually dependent factors and the former is the one usually specified.



Radial Play — Maximum distance one race may move diametrically with respect to the other without the application of measurable force when both races lie in the same plane.

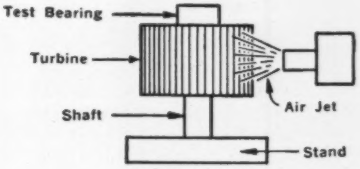


Axial Play — The maximum relative axial movement of inner race with respect to the outer, when both races are coaxially centered, without the application of measurable force.

TORQUE TESTS

Sensitive instruments require bearings with minimum inherent friction. Starting, or breakaway, torque is most often used to define limits. This is the force necessary to induce rotation from standstill under clearly established conditions of mounting and loading.

Torque tests can reveal much about the true quality and geometry of the bearing. Investigations being conducted constantly are producing valuable contributions to the refinement of instrument bearings.



TORQUE TESTER

MOUNTING PRACTICE

An improper fit to the shaft or housing can cause malfunctioning and failure of a precision bearing. The factors vary so with each application that bearing manufacturers are reluctant to make definite recommendations unless adequate information is furnished. The user cannot be sure that he has selected proper fits unless he has considered the variables involved in the manufacture of both instruments and bearings.

For selective assembly "coded bearings" can be supplied. This involves sorting bores and outside diameters in .0001" increments. It produces four possible groups within the quantity ordered but quantities in any *one* group cannot be assured. Coding should be specified only when definite advantages justify the additional cost.

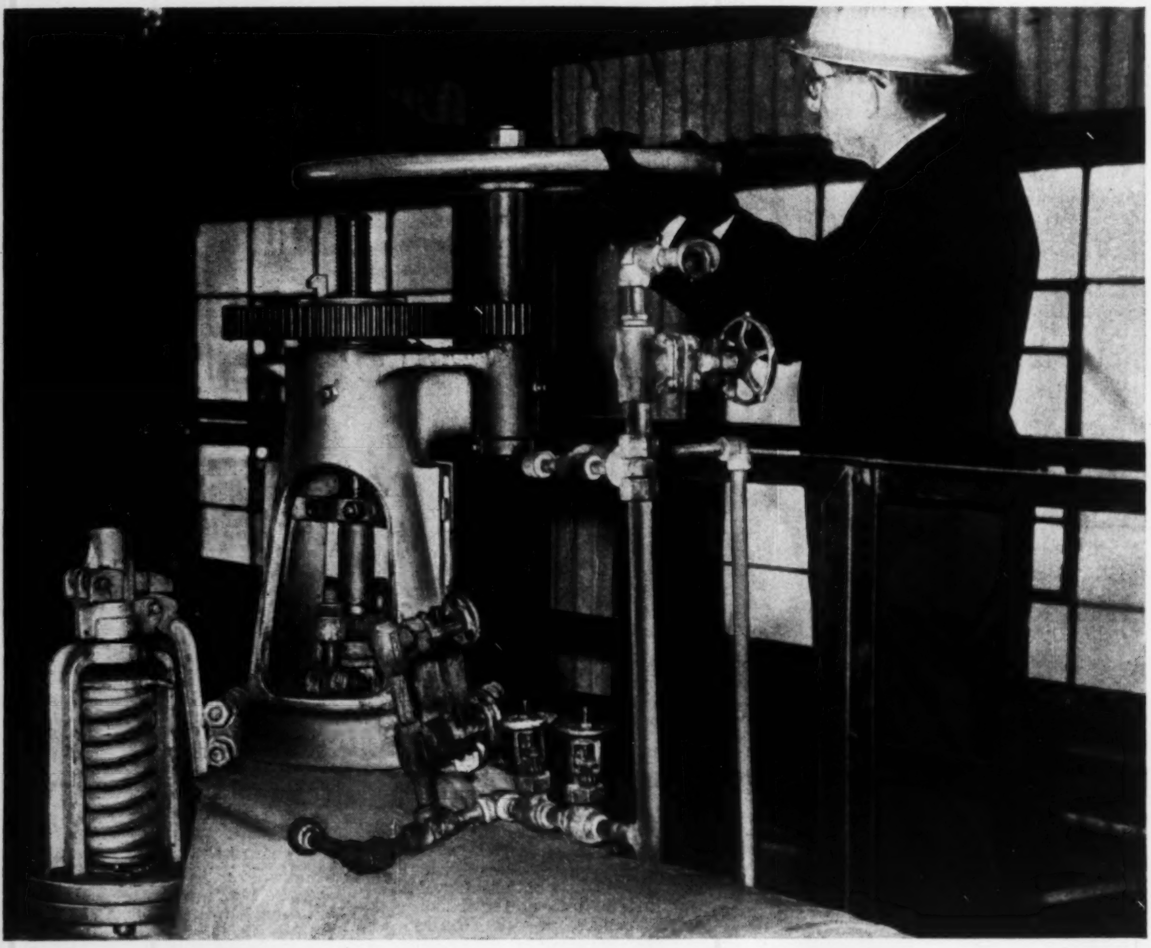
DESIGNERS HANDBOOK *FREE* TO ENGINEERS

Micro Bearings

If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

Free to engineers, draftsmen and purchasing agents.

Write New Hampshire Ball Bearings, Inc., Peterborough 1, N.H.



This Crane valve on superheated steam since 1946—with no maintenance

You'll spot cost-saving performance in the record behind this Crane valve—it has been on duty an even decade of years, with no maintenance at all!

Neches Butane Products Company installed this Crane 8-inch, 900-pound Pressure-Seal angle stop-check valve in 1946 in its butadiene plant in Texas. On superheated steam boiler service, this valve has never failed to close tightly and surely—and operate smoothly and easily—with no sticking, no troubles—no need to go near it with a wrench.

There's no question that dependability is a must in service like this. Minimum restriction of steam flow—plus smooth, positive and quick seating on backflow—*must* be provided for safe, steady boiler operation. And Crane stop-check valves can do it—*have* been doing it for years and years.

Before you specify any valve, be sure to look into the advanced designs and materials, the broad selectivity and service suitability of the great Crane line. You'll find everything you need in valves and fittings—built to the highest standards of quality. Get full information from your local Crane Representative, or write to address below.

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PIPE • KITCHENS • PLUMBING • HEATING

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- *POSITIVE* Bonding and Permanent Anchorage of Inserts
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- Excellent Arc Resistance: 250 Seconds ASTM
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SUPRAMICA® 555 CERAMOPLASTIC . . .

. . . has many important properties that will significantly **improve** your product's performance! No need to choose or balance insulation advantages . . . specify SUPRAMICA* 555 for the most **nearly perfect** combination. This unique formulation of high quality electrical glass and pure synthetic mica has the built-in versatility to surpass extra-stringent performance requirements. For complete technical information about SUPRAMICA 555 ceramoplastic insulation, and MYCALEX design and custom precision-molding services, write to Department 224.

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Primarily designed for pencil, this modern cloth stands unequalled by any product of its type for durability and reproduction performance! It readily takes pencil hardness up to 8H. Blue or white.

No. 375 "GUIL-TRACE"

Exclusively designed for ink, this new and better cloth is unmatched for its superb acceptance of ink, maximum contrast in printing, top reproduction speed. Blue only.

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Here it is! The truly modern and wonderfully improved all-purpose tracing and drawing cloth that you can use *profitably* for every job in your drafting room!

This remarkable cloth just can't be damaged by perspiration, spilled drinks, or repeated use of regular drafting room solvents. It readily accepts pencil *up to 9H hardness,* can also be used with ink. Its completely clear body, high translucency, and high permanence assure sharp, good-looking tracings and drawings that produce fine prints, even after long periods of storage.

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Try this all-modern, all-purpose tracing and drawing medium. Here is the smallest cost going into a tracing or drawing, but one of the most important. Send today for your free 8½ x 11-inch sample sheet. Blue or white.

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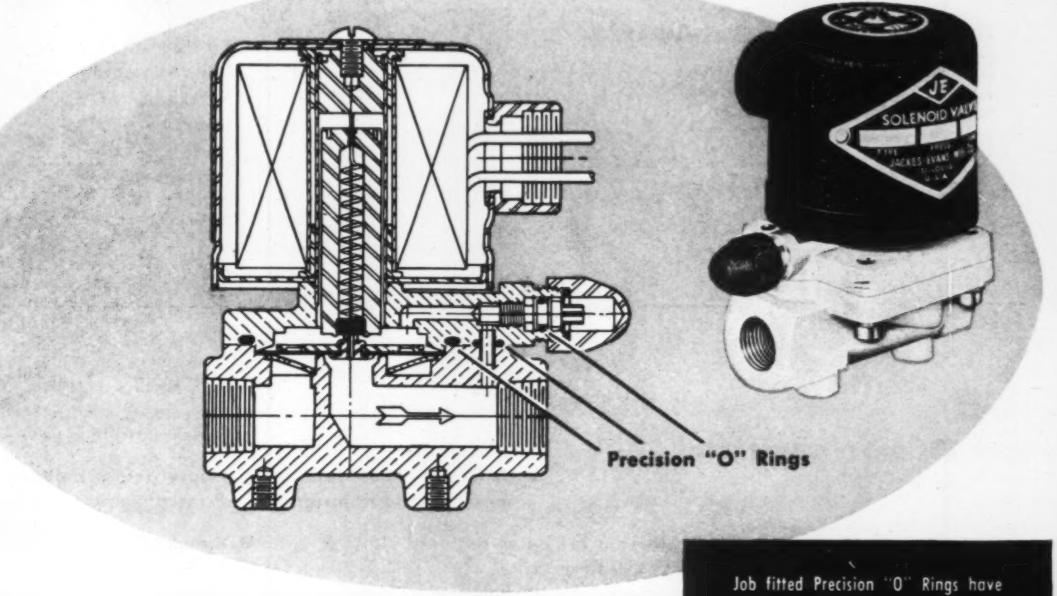
SPECIAL PRECISION "O" RING meets low temperature flexibility requirements



Job fitted Precision "O" Rings have solved hundreds of industrial, aircraft and automotive sealing problems.

Resiliency maintained at 1 P.S.I.

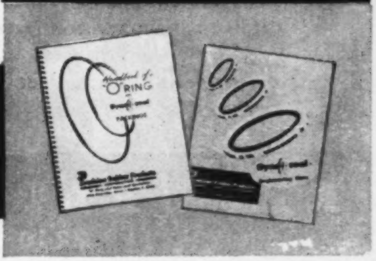
Precision "O" Ring compound 233-70 was developed especially for refrigerant service. It is used in the solenoid valves manufactured by Jackes-Evans Company of St. Louis, Mo. This compound assures the right chemical resistance and low temperature flexibility required for uninterrupted, maintenance free operation of refrigeration equipment using Freons.

Precision has developed thousands of special "O" ring compounds to provide the exact chemical and physical properties required for each specific job. Precision "O" Rings are quality controlled – compression molded – rigidly inspected – the finest made! They are made to all military and commercial specifications in hundreds of sizes.

What is your sealing problem? There is an expert – the Precision engineer – ready to help you in product design and "O" ring specifications. You can rely on him – and on Precision, the world's largest exclusive producer of "O" Rings. Put Precision in your plans!

Hot water circulation for heating in thousands of Levittown homes is controlled by Jackes-Evans Solenoid Valves—made extra dependable with Precision "O" Rings.

Write for your free copies of Precision catalogs on "O" Rings and Dyna-seals



Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialists

Dept. 6, Oakridge Drive, Dayton 7, Ohio

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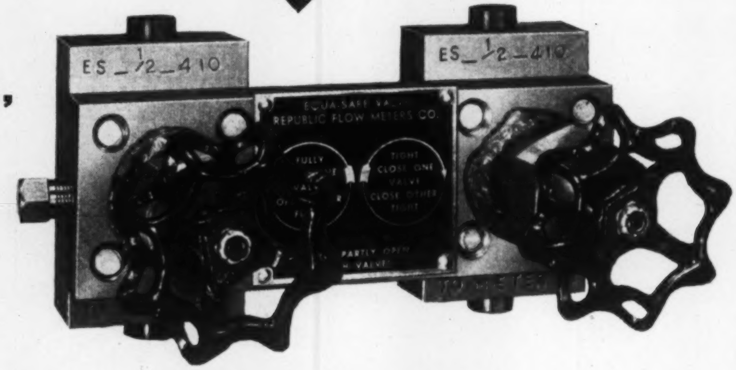
NOW AVAILABLE

Valve Manifolds that STOP Mercury Blowing, Damage to Differential Bellows and Diaphragms



- **CANNOT throw full line pressure across bellows, mercury or diaphragms of ΔP instruments.**
- **Replaces 3 or 4 conventional shut-off valves, fittings, etc.**
- **Rated to 4000 psi (cold)**
- **Available with angle, 3-way or through-type bodies threaded or socket- welded connections.**

No conventional built-up valve manifold affords the protection EQUA-SAFE *automatically* gives to differential pressure type instruments. And no built-up valve manifold can beat the low installation time or low maintenance required by EQUA-SAFE valves.

The "secret" of EQUA-SAFE's protection is in the common bridge-type bonnet and the two double-seating valves it connects. *When either valve is operated* (and sequence does not matter) *pressures in the two chambers of the differential instrument are automatically equalized through the bonnet.* As soon as both valves are fully "opened" (stem out) the instrument is on the line, with no leakage between sides. When both stems are in, the instrument chambers are interconnected and completely sealed off from primary connection pressures. Teflon packings are under pressure only while the stems are traveling from "seat" to "backseat", or vice versa!

Standard EQUA-SAFE valve manifolds are made of carbon and/or stainless steel, depending on your requirements. If your requirements are unusually severe, remember that EQUA-SAFE valves can be made of *any bar stock material that can be machined and welded!* When inspection or maintenance are needed, this bolted-block construction pays off again. EQUA-SAFE valves can be completely dismantled without breaking any pipe connections, and the inlet seat can be dressed up in place. A reversible backseat ring gives double wear, and is merely turned upside down to present a brand new seat.

Get the entire story on what EQUA-SAFE valves can do for your differential instrument installations. Write for Republic Bulletin No. 56-1, or ask your Republic engineer. Now that there is a top-quality instrument valve manifold for ΔP instuments, you should definitely investigate its applications in your plant.

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois

Bundy teams up with customer in designing more efficient compressor discharge tube

Here's just a sample of the help Bundy engineers can give you with your design problems

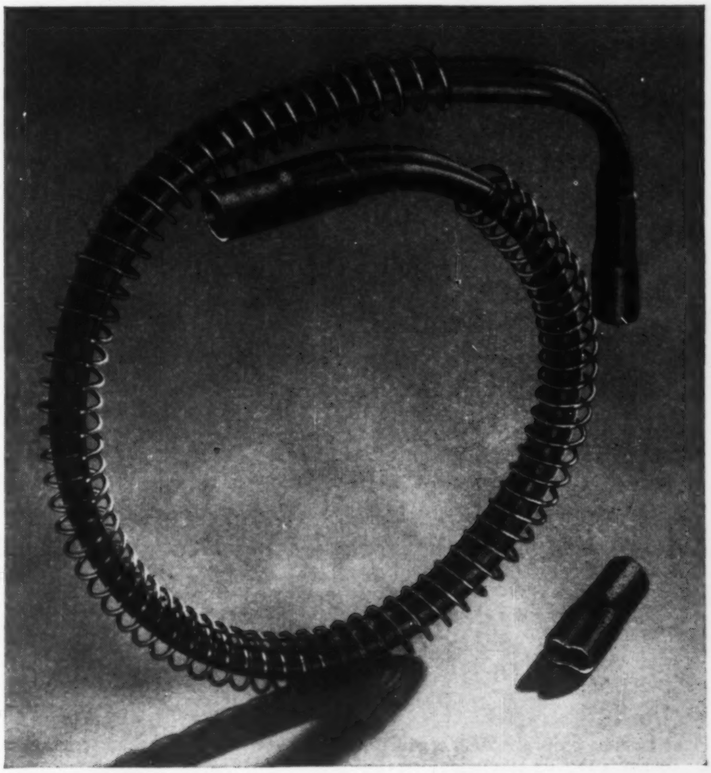
A leading manufacturer of refrigeration compressors—and a long-time Bundy customer—had this problem: an extra-sturdy compressor discharge tube was needed for use in its new, smaller, more efficient compressor. Together, Bundy® engineers and the manufacturer worked out the ingenious solution shown at right.

Bundy customers have come to expect this kind of teamwork when they deal with Bundy. Bundy engineers take pride in solving tricky tubing problems. They'll gladly work with you at the design stages of a new product; they'll also help you iron out kinks in your present tubing designs. Either way, you benefit from their years of problem-solving experience.

You benefit, too, from the inherent qualities that make Bundyweld Steel Tubing the world's finest small-diameter tubing. Bundyweld is the only tubing double-walled from a single metal strip, copper-bonded through 360° of double-walled contact. Bundyweld is leakproof; thinner walled, yet stronger; has high thermal conductivity; has high bursting strength. Bundyweld is not only the safety standard of the refrigeration industry; *it is used in 95% of today's cars, in an average of 20 applications each.*

For help with your tubing design problem, call, write, or wire us today.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



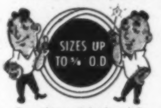
Problem: Manufacturer needed extra-sturdy refrigeration-compressor discharge tube for new, smaller, more efficient compressor.

Solution: Discharge tube uses *double* tube for extra strength, superior resistance to vibration fatigue; the two separate tubes are brazed only at end fittings. Steel coil-spring sheathing muffles the noise that results from the vibration of this part. Discharge tube is designed so that O.D. of two tubes together is the same as O.D. of bifurcated Bundyweld end fittings, allowing spring to be slipped on after fittings have been brazed to double tube. Lower right: detail of formed Bundyweld end fitting.

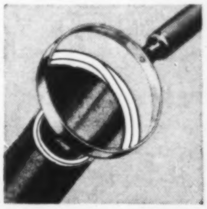
Bundyweld starts as a single strip of copper-coated steel. Then it's

. . . continuously rolled twice around laterally into a tube of uniform thickness and passed

through a furnace. Copper coating fuses with steel. Result . . .



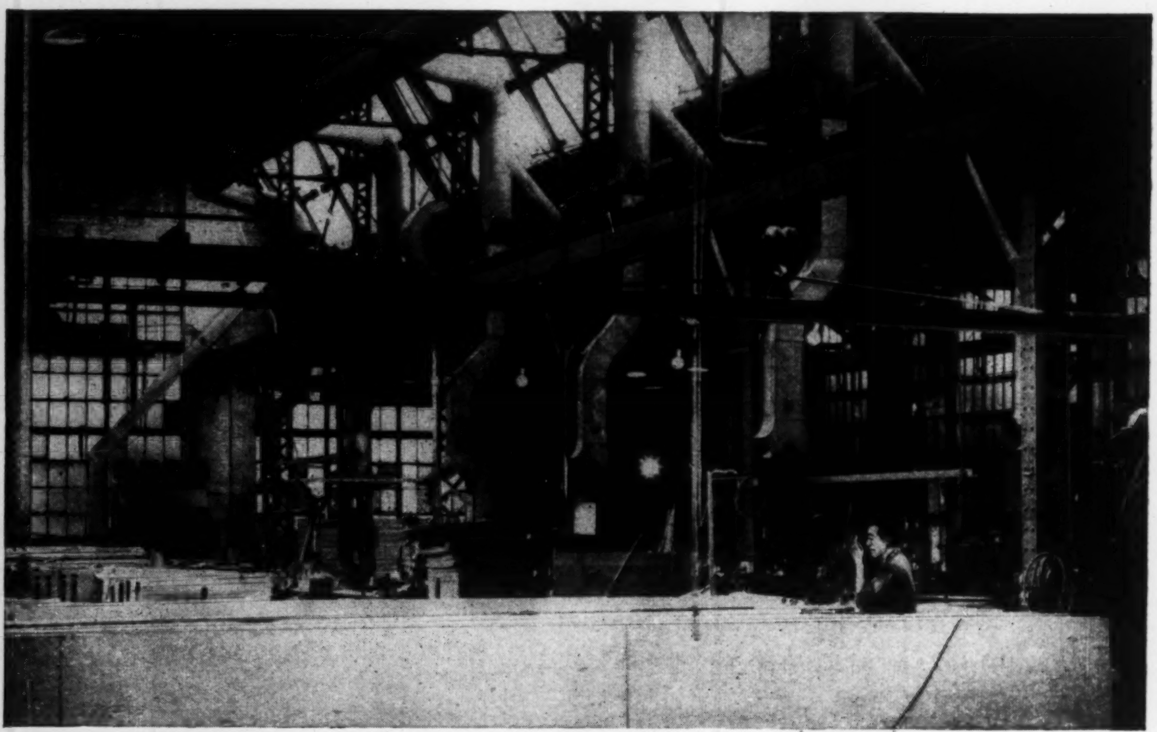
Bundyweld, double-walled and brazed through 360° of wall contact.



NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP



This Dravo *Counterflo*, on the far wall, distributes heat up to 150 feet away. Richards-Wilcox's complete Dravo system of 25 units provides 21,700,000 btu per hour to a 6 acre plant area. Ductwork visible is part of abandoned steam heating system.

Richards-Wilcox more than doubles heating capacity

...cuts heat operating costs in half!

Plant heating problems first began for the Richards-Wilcox Manufacturing Co. of Aurora, Illinois, during World War II. Then, the existing steam plant, operating at full capacity, could not meet the heat requirements for new production areas. Immediate solution was the addition of two warm air space heaters.

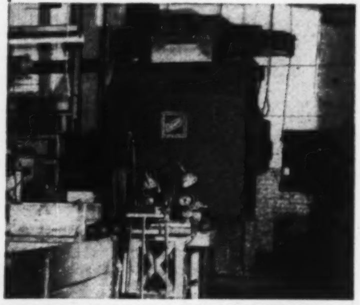
Later, a 750,000 btu Dravo *Counterflo* heater was installed to serve additional expansion. But in 1951, facing even more expansion, Richards-Wilcox plant men thoroughly surveyed their total plant heating problem.

The existing boiler had to be modernized, an additional boiler and accessory equipment had to be added. Operating costs of this contemplated step were discouragingly high! Experience with space heaters suggested an alternative that promised real economies—dismantling of the steam plant and converting the entire plant to warm air heating. This plan was adopted on a 3 year basis.

From 1951 through 1953, twenty-four Dravo *Counterflo* heaters were put into service. Richards-Wilcox personnel installed recording instruments on every unit to determine fuel consumption and efficiency. After two years of service, the records show that Dravo heaters provided more than enough heating capacity for complete worker comfort and had *cut operating costs to less than half of the former system.* Service costs, too, were 50% less than anticipated.

Such economy is only a part of the many exclusive advantages Dravo heaters can bring in heating your plant, warehouse or building. It will pay you to thoroughly investigate quality Dravo heating systems—and see the dollars and cents reasons behind every feature. For prompt information, mail the coupon today.

At the Richards-Wilcox plant, Dravo heaters serve dual heating jobs—heating both the local area and, through duct take-offs, serve adjacent areas.



Dravo Corporation, Department A-1208
Fifth & Liberty Avenues
Pittsburgh 22, Pa.

I am interested in Dravo Heaters for ____________

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Company ____________
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Pittsburgh 22, Pennsylvania
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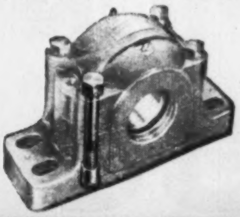
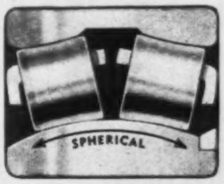
MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings

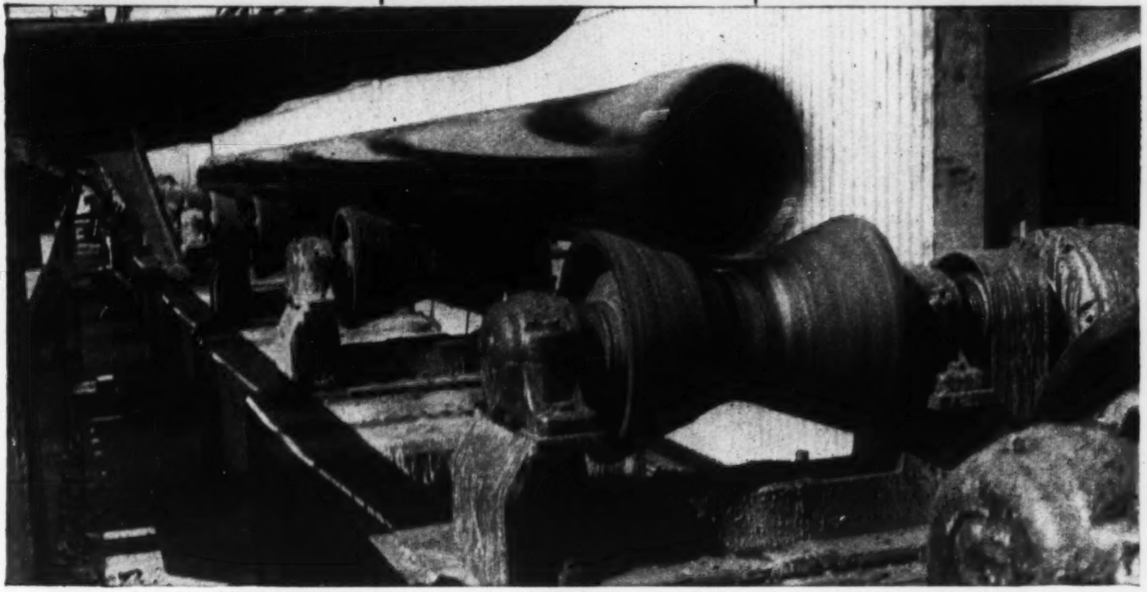
SUPER-RUGGED CAST STEEL HOUSING. Proper positioning of cap on base is assured by large-size dowels. Four heat-treated thru-bolts and serrated steel nuts firmly clamp cap and base together.



CHOICE OF SEALS. Spiral labyrinth steel seals, left, are for oil or grease lubrication and heat conditions. Combination felt and synthetic rubber contact-type seals, right, for grease lubrication.

SELF-ALIGNING ROLLER BEARING is self-contained and adjusted at the factory—needs no shims or alignment rings at installation. Design assures free rolling under even the toughest conditions.





Link-Belt "Mill Bearings" with cast steel housings withstand severe impacts and heavy loads in this modern pipe mill.

"Mill Bearings" with cast steel housings

designed by Link-Belt to take industry's heaviest loads and hardest impacts

"Mill Bearings" are now available for shafts up to 11 in.

● To stand up to the sudden shocks and impact loads met in steel mills, mines, foundries, oil field applications and on heavy equipment, Link-Belt has designed the extra tough "Mill Bearing." It's the precision Link-Belt self-aligning roller bearing mounted and protected in a durable cast steel housing.

Thoroughly-proved Link-Belt "Mill Bearings" maintain full load capacity even with shaft deflections and misalignment often existing in extremely heavy service. And their simple, efficient design assures long life and free rolling.

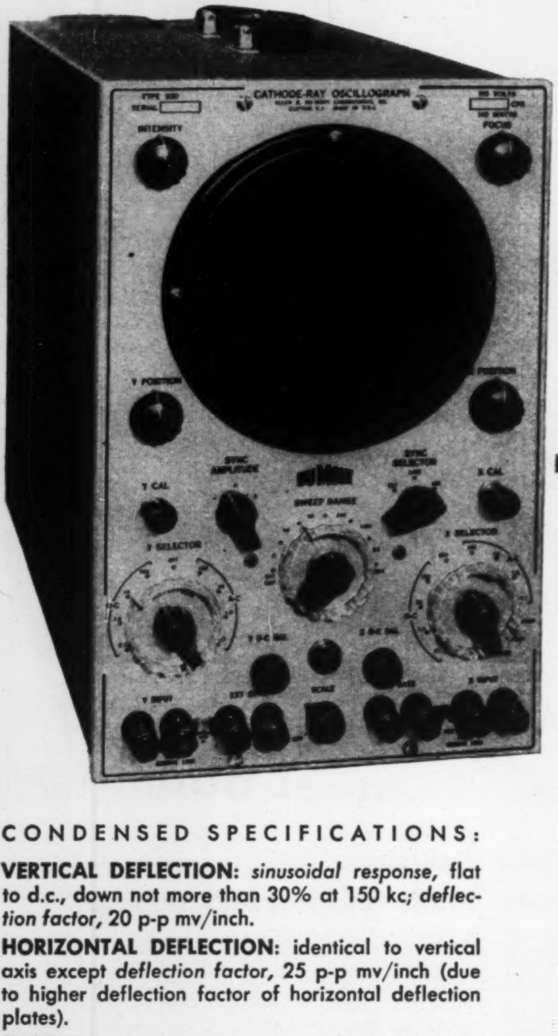
Link-Belt makes industry's most complete line of ball and roller bearing blocks. So whatever you need, you'll find the answer in this quality line. Ask any of the Link-Belt offices or an authorized stock-carrying distributor for Data Book 2550 and Book 2565A on "Mill Bearings."

13,992

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock-Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.



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Not just another low-frequency cathode-ray oscillograph but a decidedly grown up instrument combining the best features of the laboratory standards by Du Mont which have gone before it. All these features and more:

- **Exceptional stability—all voltages regulated**
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- **Amplitude calibration on both axes**
- **Accurate X-Y plotting at frequencies from d.c. to 150 kc.**
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- **Superior sweep linearity with hard-tube circuit**
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- **Automatic beam brightening for transient plots**
- **High brightness—3KV acceleration**
- **Provision for very slow sweep rates**

CONDENSED SPECIFICATIONS:

VERTICAL DEFLECTION: *sinusoidal response,* flat to d.c., down not more than 30% at 150 kc; *deflection factor,* 20 p-p mv/inch.

HORIZONTAL DEFLECTION: identical to vertical axis except *deflection factor,* 25 p-p mv/inch (due to higher deflection factor of horizontal deflection plates).

SWEEPS: *mode,* driven or recurrent; *frequency,* 2 cps to 30 kc; *beam gate,* automatic during forward sweep.

AMPLITUDE MEASUREMENT: (both X and Y axes) *range,* 0.1, 1, 10 and 100 volts full scale; *accuracy,* ±5%.

PHASE SHIFT: *amplitude controls at max.,* less than 1° below 150 kc.

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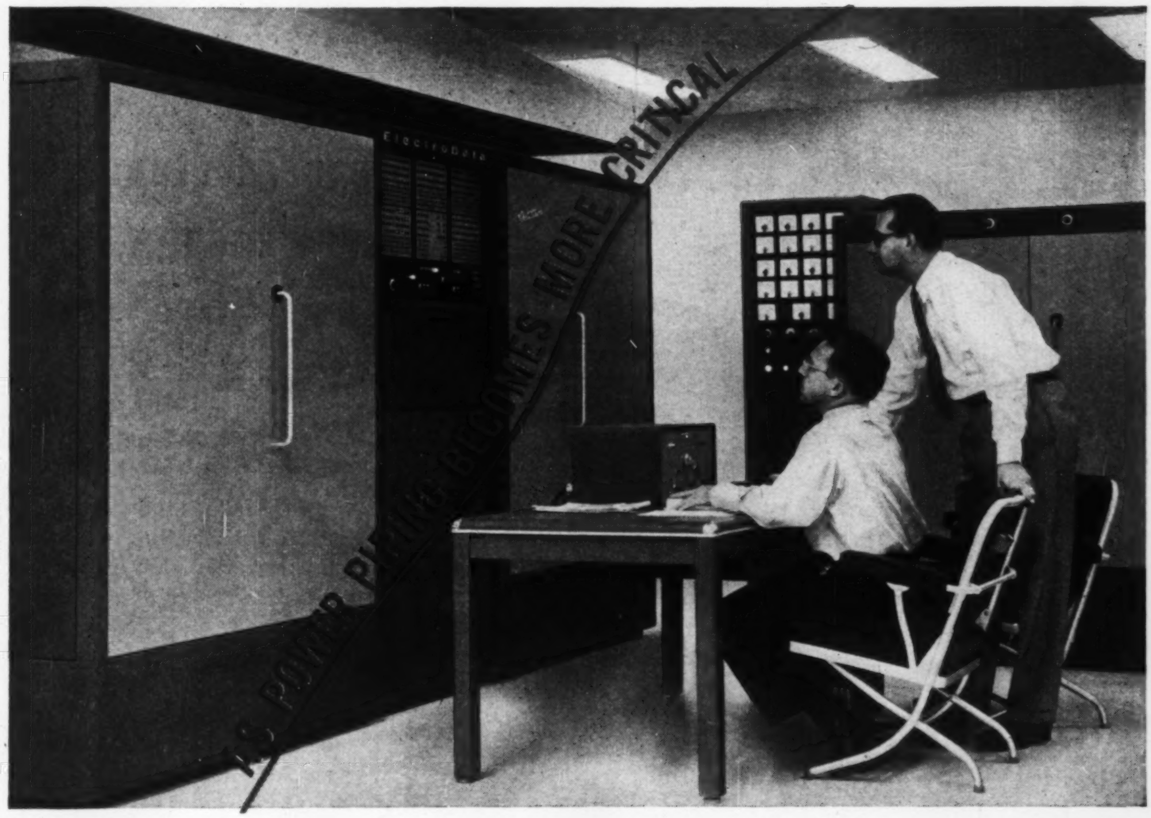
AS POWER PIPING BECOMES MORE CRITICAL
Electrodata

Kellogg's Design Calculation Techniques Keep Pace

Latest and most valuable electronic addition to The M. W. Kellogg Company's facilities for solving the design calculation problems of power piping customers is a new, large magnetic drum digital computer. It can execute 500 arithmetical operations per second; conservatively can solve 40 simultaneous equations in 30 minutes; and has a memory capacity of over 4000 ten-digit words. This computer is now in use at Kellogg's new New York Headquarters, and supplements a smaller computer which has been employed for some time at M. W. Kellogg's Jersey City laboratories.

This new computer enables The M. W. Kellogg Company's engineering staff to undertake a far greater number of precise calculations in less time than ever before and, as a result, to determine the optimum main and reheat steam piping designs for steam-electric power plants in minimum time.

A cordial invitation to see the new Datatron computer at work is extended to consulting engineers, and to engineers of power generating companies and their equipment manufacturers. Appointments may be made by contacting the office of the Sales Manager, Fabricated Products Division, The M. W. Kellogg Company, 711 Third Avenue, New York 17, N. Y.

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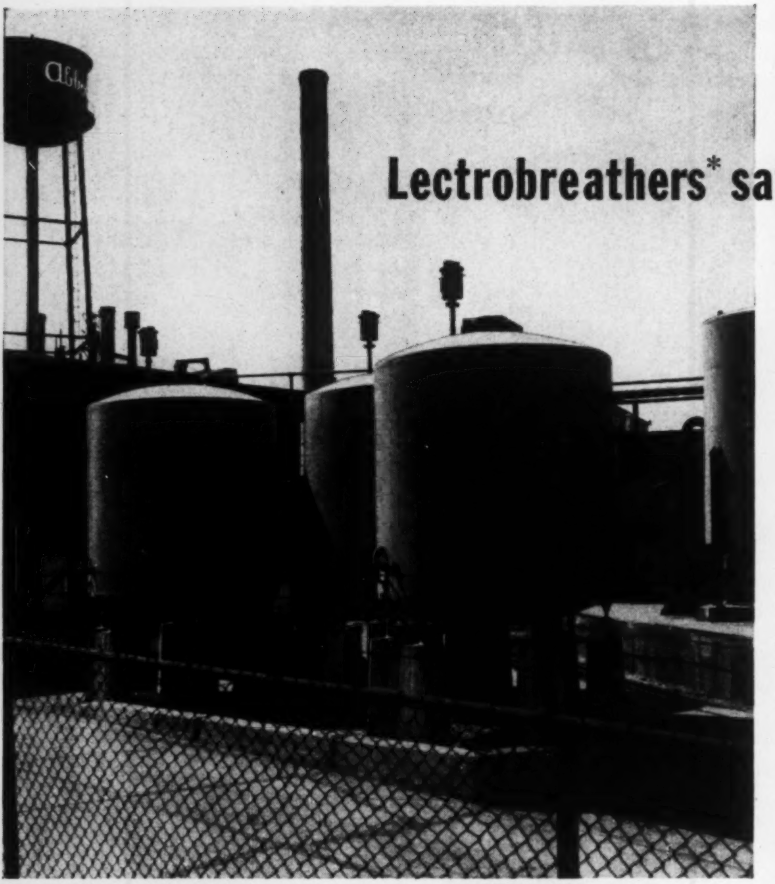
POWER PIPING—THE VITAL LINK



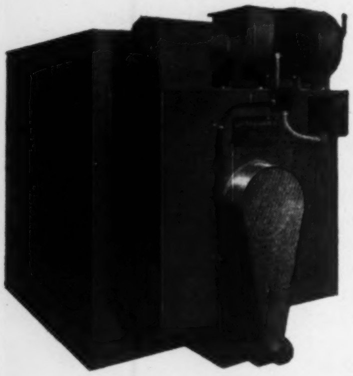
Lectrobreathers* safeguard chemicals in storage—permitting carload purchases

● Buying liquids in tank car lots saves money. But profits are quickly washed out if storage tanks are allowed to inhale wet air as they breathe, contaminating their contents.

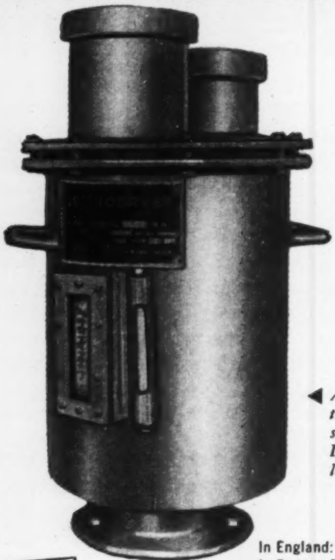
Abbott Laboratories solved this problem by installing Lectrobreathers on many of their outdoor and indoor storage tanks. Now, as pressures vary and those tanks draw in outside air, that air is DRY. The original high quality of their contents is preserved.

Lectrobreathers and Lectrodryers make certain that any tank, little or big, breathes only DRY air. For help in selecting the equipment you need, write Pittsburgh Lectrodryer Company, 335 32nd Street, Pittsburgh 30, Pennsylvania (a McGraw Electric Company Division).

You see Lectrobreathers extending above tanks and rooftops at the Abbott Laboratories plant in North Chicago, Illinois.



Where volumes of air are large, as in a tank farm, a Lectrodryer serves as a breather. Its DRYing-reactivation cycle is continual, so it stays right on the job.*



◀ *A tank breathes freely as air passes through the Activated Alumina adsorbent and is dried DRY. When a Lectrobreather needs reactivation, it is lifted off and a spare takes its place.*

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY
WITH ACTIVATED ALUMINAS

LECTRODRYER

* REGISTERED TRADEMARK U. S. PAT. OFF.

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DETROIT ROTOGRATE • ROTOSTOKER • ROTOSTOKER (TYPE C-C)

HIGH ECONOMY AND AVAILABILITY • LOW MAINTENANCE

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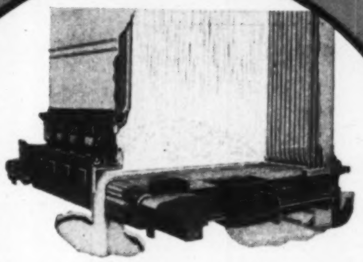


DETROIT ROTOGRATE

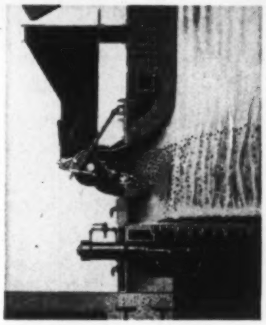
Original spreader stoker with forward moving grates that discharge the ash at the front. Our long experience has contributed to many exclusive refinements and features of design. Proven superiority with hundreds installed here and abroad. For capacities up to approximately 400,000 pounds of steam per hour.

Detroit Stokers burn any Bituminous Coal or Lignite without special preparation. Commercial sizes ranging from ⅜" x 0" to 1¼" x 0" are ordinarily used. High burning rates without clinkering difficulties. Also many refuse fuels including wet bark, hogged wood, bagasse, etc. are burned separately or in combination with coal; efficiently and without smoke.

Widely fluctuating loads are easily handled. Parasite power is negligible. High overall efficiencies at all capacities are assured. Maximum availability and very low maintenance.

Buy "Detroit"—They are "the most".

2



DETROIT ROTOSTOKER

For small and medium size units. Power Dumping, Hand Dumping or Stationary grates to fit the furnace provide desired capacity under full automatic control.

3

DETROIT ROTOSTOKER (TYPE C-C)

Continuous cleaning type particularly suited to highly fluctuating loads. Many sizes for capacities of 5,000 to 75,000 pounds of steam per hour. Reciprocating grates discharge ash at front. No basement is required.

DETROIT STOKER COMPANY

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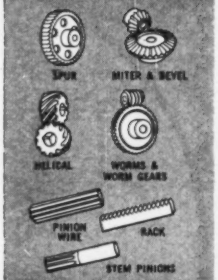
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RACK
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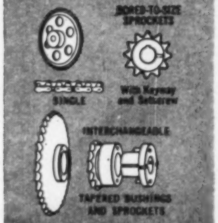
SPROCKETS & CHAIN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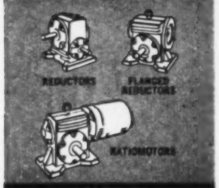
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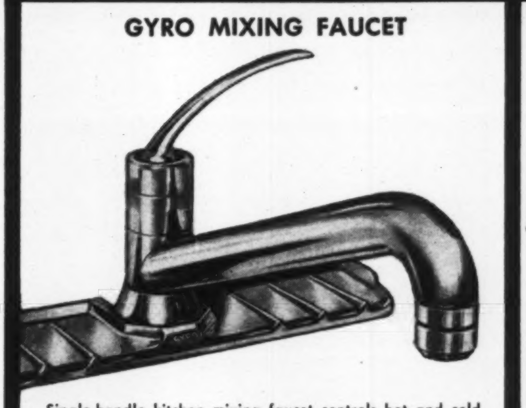
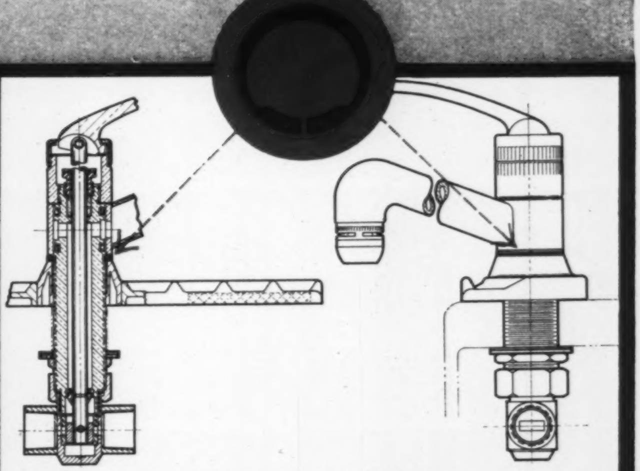
56BG-NC23

Waldes Truarc ring reduces valve body from 1$\frac{5}{16}$" to 1$\frac{1}{16}$", eliminates chrome plating

GYRO MIXING FAUCET



Single-handle kitchen mixing faucet controls hot and cold water, as well as volume. Radical design has no seals or spindles to replace. One Waldes Truarc retaining ring allows complete assembly and disassembly from either top or bottom of unit.



Aluminum Truarc Ring (external inverted Series 5108) acts as bearing retainer, insures precise alignment of spout and escutcheon, gives uniform shoulder with machining. Truarc ring provides shoulder that would otherwise require machining valve body to 1 5/16" against 1 1/16" used. Also eliminates expensive chrome plating of valve body.

Gyro Brass Manufacturing Corporation of Westbury, L. I., N. Y., uses a single Waldes Truarc retaining ring (Series 5108) both as a positioner and retainer on their Gyro Mixing Faucet. Aluminum Truarc ring not only eliminates expensive machining, but also does away with a chrome plating process that would be necessary if the shoulder were made of the solid material of the body.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered... quick and easy to assemble and disassemble.

More than 5,000 stock sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

Send for new catalog supplement

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TRUARC®
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WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
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Business Address..
City...............*Zone*...............*State*...............
ME-088

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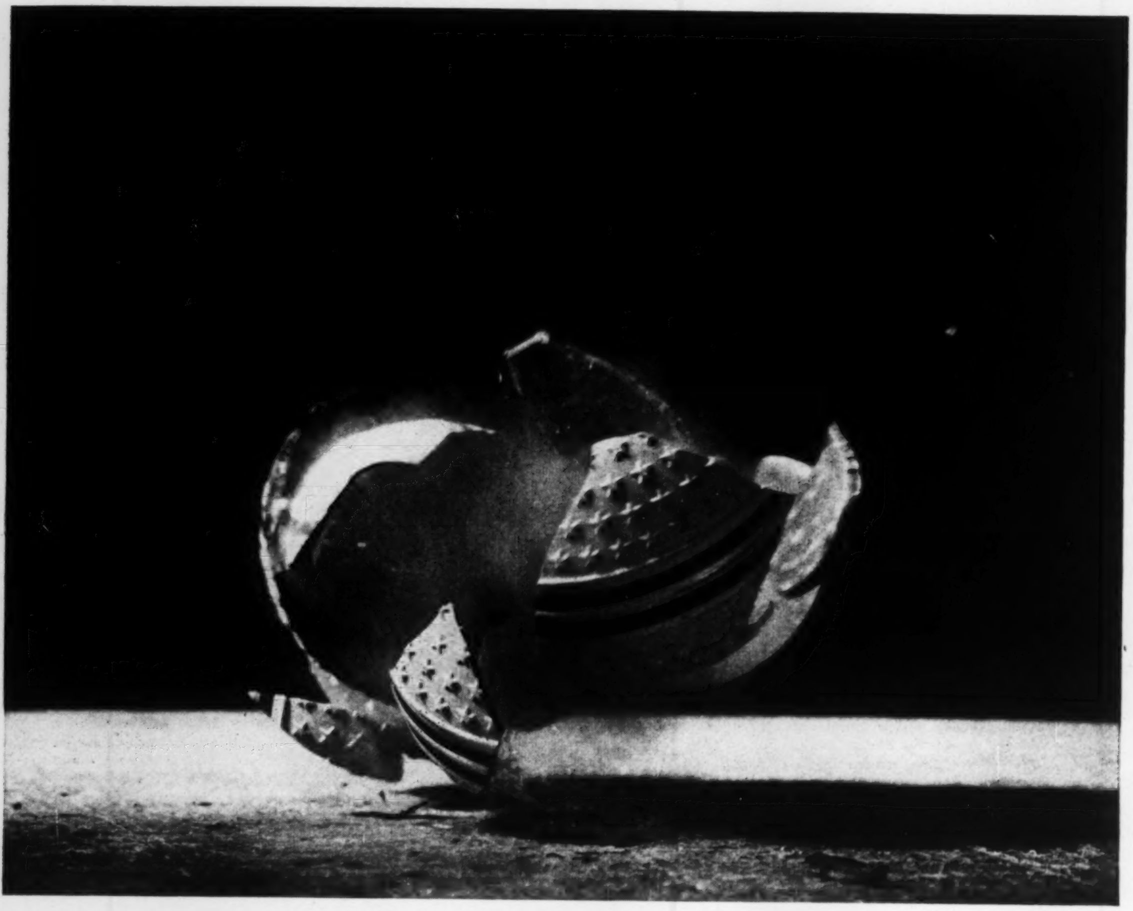

A child's rubber ball, chilled to —320°F., shatters when dropped. Electronic flash tripped by microphone 1.035 milli-seconds after contact. Photographed by Ralph Bartholomew, Jr.

When rubber shatters like pottery...

It happens right before your eyes. Still you can hardly believe the fantastic things that take place at deep sub-zero temperatures.

Rubber breaks like a clay flowerpot. Mercury freezes so hard you can hammer nails with it. Hammer a frozen orange with it, and the chips of fruit fly off like bits of granite. The very air itself turns into a bluish liquid that pours like boiling water.

You feel as if you had awakened in some dizzying space-man world. And when you see metals like tough structural steel crack up under a blow as if they were glass, you realize the puzzle confronting men who have to work with temperatures reaching down into the depths near Absolute Zero.

An oxygen vaporizer, for example, has to withstand a bursting pressure test of more than two tons per square inch at —300°F. A helium liquefier works at 455° below zero Fahrenheit.

How in the world do they make equipment to stand such pressures and temperatures without breaking up or bursting?

Strangely enough, the practical answer to this difficulty is an easy one: INCO Nickel Alloys. One of the many peculiar advantages of nickel alloys is the fact that these sub-zero temperatures have little or no effect on their inherent toughness and ductility. They simply become still stronger.

(By the way, if you would like more data on this subject you are welcome to a copy of "High Properties at Low Temperatures" by our Director of Technical Service.)

The point is, maybe you are being bothered with some metal problem in your product or plant that would be just as easy to solve with one of these INCO Nickel Alloys. The first step is to outline the trouble and send it along for study to The International Nickel Company, Inc., 67 Wall St., New York 5, N. Y.

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Nickel Alloys Perform Better, Longer

MECHANICAL ENGINEERING

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AUGUST 1956

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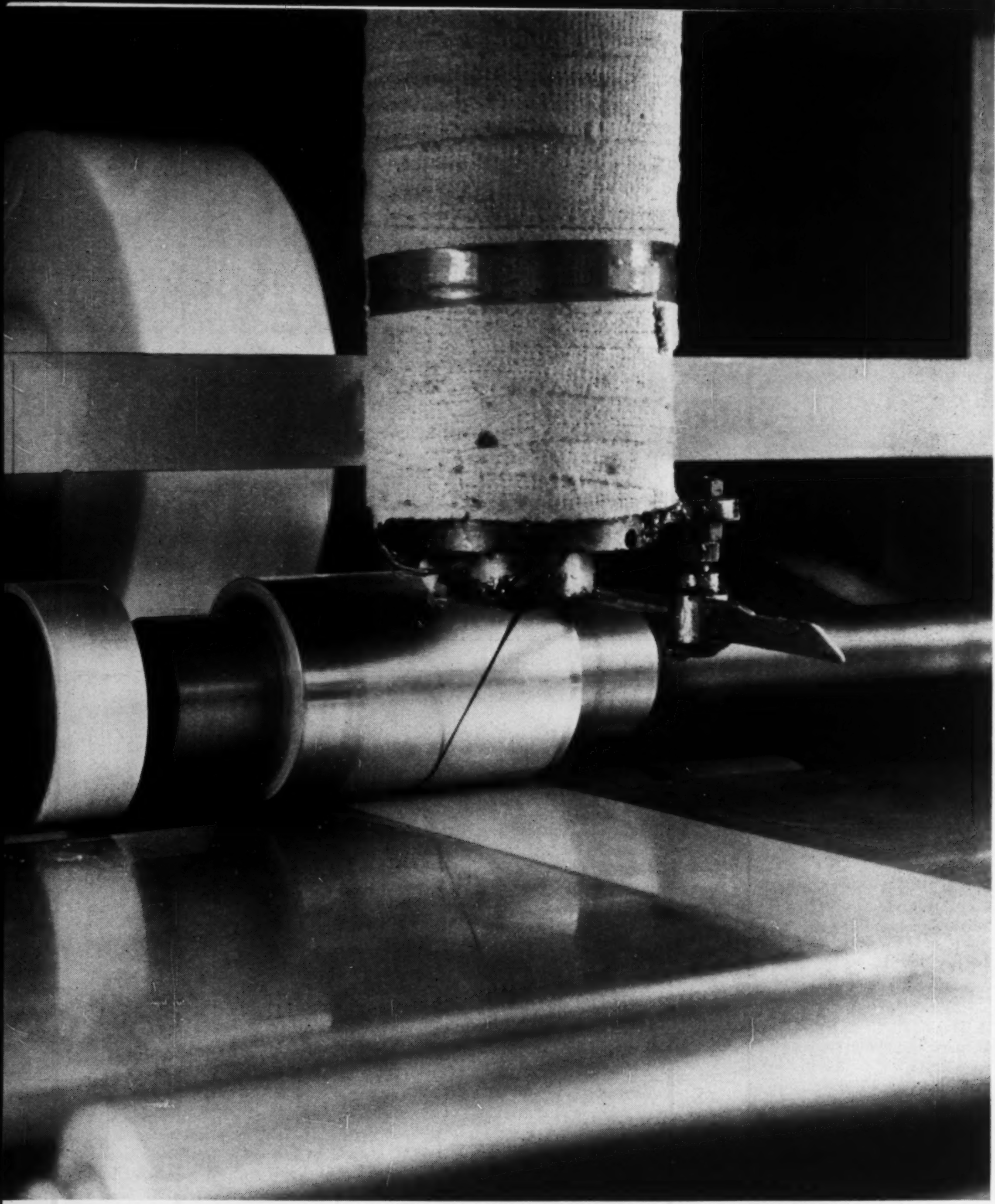

A continuous seal for polyethylene film...

... produced at rates of 500 fpm or higher is made possible by a new molten bead-sealing principle developed by Bakelite Company, a Division of Union Carbide and Carbon Corporation. These researchers came up with the idea of feeding a continuous bead of molten Bakelite polyethylene resin between layers of film to fuse them together at high speeds. Conventional methods that seal 10-mil film at a maximum rate of 25 fpm and $1^1/_2$-mil films at 150 fpm apply heat from the outside. The new principle extrudes a hot filament of polyethylene between two layers of film at the point where they are to be sealed rather than attempting to drive the heat through the films. The new technique may be used to seal polyethylene film of almost any thickness and is applicable to the sealing of polyethylene coated paper, polyethylene laminates, and paper.

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AUGUST 1956

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George A. Stetson, *Editor Emeritus*
J. J. Jaklitsch, Jr., *Acting Editor*

MECHANICAL ENGINEERING

Valedictory

On July 2 the editorship of this magazine changed hands. After more than 25 years the editor becomes editor emeritus and his associate, acting editor.

In the face of such an event the editor emeritus claims the privilege of addressing his readers in a more personal manner than usual. One cannot relinquish such a post as editor without thanking his readers for the attention and courtesy they have shown him in the past and bespeaking for his successor the same loyal support that members of The American Society of Mechanical Engineers have always given to those who edit their publications; or without paying tribute to the hundreds of persons whose services and papers have made those publications possible.

It has been a rare privilege to serve as editor of The American Society of Mechanical Engineers and to have enjoyed the personal relationships and experiences that constitute the greatest satisfactions to be derived from filling the post. Long hours of routine work on manuscripts and proofs, the frustrations and disappointments resulting from adverse economic conditions, and the limitations of physical and mental powers are crowded out of memory by recollections of great men and significant events and a sense of gratitude that one has been fortunate enough to know and observe them.

Only an obtuse reader of what has been printed in this space from month to month could fail to realize that the writer has a high opinion of the importance of engineering in modern society and is optimistic of the ability of the engineering profession to justify that opinion. The attitude has been that of a realistic idealism which the frailties and failures to which each of us must confess can never overthrow and which, if one looks backward over the past and forward into an unknown future, can be justified by any reasonable extrapolation of human progress. On that faith in the destiny of engineering and the future growth of the Society in terms of its significance to humanity is based the writer's conviction that his successor will exercise his energy and talents in the years to come as he has in the past in the improvement of this magazine and other ASME publications as a service to his fellow engineers and the nation.

A principal reason for the faith this writer has in engineers arises from the close contacts he has had for 40 years with the officers and members of the Council and committees of this and several sister societies. Through these contacts, formal and informal, which frequently have ripened into friendship, one can penetrate the outer shell that each man presents to the world and thus become aware of the inner man, understand his personal philosophy of life, and learn what and how he thinks. It is gratifying to report that the qualities of nobility, integrity, and unselfish dedication far outweigh those baser qualities which an unfortunate encounter or a superficial examination may sometimes reveal. This happy discovery of the writer has led him to assume, and usually with justification, that engineers unknown to him except as authors or readers are also men of goodwill; and men of goodwill will always move in the direction of a better profession serving a better world.

It is also gratifying to report that when the Society places responsibility on its editor it gives him authority to discharge that responsibility. The two Secretaries under whom the writer has served, the many Presidents, members of the Council, and the Publications Committee with its ever-changing personnel have established policies under which the editor operates, but they have never usurped his duties and authority. They have offered advice, suggestions, aid, and friendly criticism, but they have adhered to the doctrine that one man is responsible for the conduct of this magazine. In a quarter of a century this writer does not recall a single instance in which he has been ordered to publish or not to publish an item. No one has ever dictated what he should say or how he should say it, or what paper should be or should not be published. This circumstance is a high tribute to the Society and is further evidence of the extraordinary qualities of engineers in the handling of their affairs.

No editor runs a magazine single handed. He has a staff, a printer, readers, authors, and someone to whom he is responsible. The editor emeritus is fortunate in having had throughout his many years as editor the same managing editor, the same printer, and the same boss—the Secretary. When one considers the duties of the managing editor and the editorial staff one is forced to the conclusion that the managing editor does all the hard work, keeps the staff together, and gets all the complaints, while the editor attends meetings and luncheons and gets all the credit. Mechanical Engineering has operated without an editor, but never without the managing editor and her staff.

As one editor steps down and another takes his place, Mechanical Engineering will change only for the better, keeping pace with the progress the Society and the engineering profession unquestionably will make during the years to come.

1956: The Biggest Year Yet

By Joseph W. Barker

President, The American Society of Mechanical Engineers

CLEVELAND has long been the scene of some of the most significant developments in our technology. It was 70 years ago this year that two Cleveland professors—Dr. Albert A. Michelson of the Case faculty, and Dr. Edward M. Morely, of the Western Reserve faculty—conducted their famous experiments in a basement laboratory at Case.

Six years before that, when ASME was founded, our first membership list carried the name of one Charles F. Brush, who described himself as an electrical engineer of 71 Ontario Street, Cleveland, Ohio. It was Charles Brush, of course, who made the first electric arc lights for public street lighting, used in Cleveland's public square in 1879. And just to show that times have not changed so much, this great development, this giant step forward along the path of progress, was greeted with cries of complaint from the women. They said the new lamps lighted their complexions to disadvantage.

Cleveland industry has been most influential and co-operative in the affairs of ASME. Five of the outstanding presidents of our Society have been Cleveland engineers—Worcester Reed Warner in 1897, for whom one of our highest medal awards is named; Samuel T. Wellman in 1901; Ambrose Swasey in 1904 whose great contributions launched The Engineering Foundation, which supports so many vital research projects; Edwin S. Carman in 1921; and James H. Herron in 1937. This roster might be stretched to five and a half since Past-President E. G. Bailey is a "part-time" Clevelander with the head office of the Bailey Meter Company in Cleveland. Whether five or five and a half this is certainly a distinguished contribution by Cleveland to the success of ASME.

ASME Activities Increase

In many ways, 1956 is the biggest year in ASME's history. Our membership is at a new high. We have more professional divisions than ever before. And we are holding more meetings—many more— than we have held in any other year. We have already had conferences sponsored by our Aviation, Management, Instruments and Regulators, Machine Design, Oil and Gas Power, Gas Turbine Power, and Applied Mechanics Divisions. We have held a number of joint meetings with other organizations, including one in May in Montreal, with The Engineering Institute of Canada.

Were any of these past-presidents here today, certainly they would be impressed with the tremendous growth of the Society's interests. We now have 23 professional divisions, plus a number of other activities devoted to serving the specific interests of some of our specialist members. There is something for everyone in this organization, and if you don't find what you want, the chances are you're not really a mechanical engineer.

The percentage of our 40,000 members who are able to attend this and other Society meetings is relatively small. So also is the percentage of those who at any one time voluntarily devote their knowledge, time, and talents to the preparation of papers and reports which constitute tangible and permanent evidence of the service this Society has rendered for 75 years to engineering and to the progress and defense of this nation.

However, through our publications these papers and reports are broadly disseminated for the benefit of all the world. The periodical publications, MECHANICAL ENGINEERING, Transactions, and *Journal of Applied Mechanics*, bring together in spirit our widely scattered members and advance the specialized technical activities through which each individual member may contribute more effectively to the *public welfare*. They are evidence of the educational nature of our Society.

Certainly, the work being done within the organization warrants much praise. No one can estimate the millions of man-hours that are donated every year to the dual purpose of making ASME more useful to its members, and of making the profession of mechanical engineering more useful to the world in which we live.

However, it would be only fair to point out some of our shortcomings.

For example, there is a need for the program agencies of the Society to contribute more than they have and in particular to be meticulously critical in their recommendations for membership on our divisions and standing committees. As you know, we are limited by space and budget considerations in the size of our staff. If this Society continues to grow as it has in the past, we will need to do two things. We will need to expand our staff; and we will need to ask for more co-operation from our members. The latter is most important because this decentralization of activity is one of the things that make ASME strong. And each of you derives more benefit from your membership in direct proportion as you participate in the activities of the Society.

One of our outstanding problems is that of getting our student members to transfer to associate membership when they get out of school. We are presently losing about two thirds of our student members within five years after graduation. That figure represents a great loss to all parties concerned. This has been one of the items discussed during visits with some of the Sections and Branches. Their awakened realization of the situation has led to active attempts to improve the early liaison between the new graduate and the Section in which he takes his first employment.

These are all problems that concern us as members of ASME. Even more compelling are the problems that concern us as members of the honorable profession of engineering, and as citizens of a great republic.

Shortage of Engineers

One of those problems is what has become known as the great engineering shortage. It may seem as you read newspapers and magazines, and listen to newscasters,

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Based on an address delivered at the President's Luncheon during Semi-Annual Meeting, Cleveland, Ohio, June 17-21, 1956, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

that a lot of material on this subject is being rehashed, over and over. That is not the case. What you are hearing on any given day is the latest results in a race in which we are steadily falling behind. Here are some of the most recent statistics:

In May the Research and Development Subcommittee of the Joint Congressional Committee on Atomic Energy conducted hearings in which it heard that the Russians had increased the number of trained engineers in their country from 41,000 in 1920 to 541,000 in 1954, a rise of 1200 per cent. In the same period we raised the number of our trained engineers from 215,000 to 500,000 a rise of 130 per cent, or only about one ninth of the Soviet rate. To look at it another way, we started in 1920 with more than five times as many engineers as the Russians; by 1954, they had overcome the gap and passed us by as many engineers as they had to begin with in 1920.

That trend is continuing. In the years between 1950 and 1955 Russian institutions of higher education increased the number of their engineering graduates from 28,000 a year to 63,000; our figures dropped from 52,000 to 23,000 in these same years.

All of this is happening at a time when technological advances are increasing, rather than decreasing, the need for engineers.

Is it any wonder then that the ratio of engineer-scientists to industrial production employees has risen from one for every 250 in 1900 to one for every 60 in 1950.

High Schools and the Shortage

A large part of the responsibility for the engineering shortage is traceable to the schools. The number of qualified teachers of science and mathematics in American high schools went down 53 per cent in the past five years, while high-school enrollment was going up 16 per cent. More than half of our high schools do not offer courses in physics. Only about half of them offer courses in chemistry. The students who do study those subjects are not necessarily learning them. A recent survey indicates that from 250,000 to 400,000 high-school students are taking mathematics and scientific training from teachers who have had no subject-matter education in those subjects.

The problem makes itself felt when the student reaches college age. The dean of engineering at one of our large state universities points out that slightly more than half the students who entered the university in engineering curriculums last fall had deficiencies in mathematics. Of the remainder—those who supposedly met the requirements—43 per cent could not pass the algebra placement test. That meant that a total of 72 per cent of the total applying for admission in the College of Engineering had to take review mathematics required as entrance units. That is a large percentage of students to be wasting their time in courses they should have mastered before they ever applied for college admission.

What is the answer? There is no single answer. Above all it should be emphasized that there is no national answer to this problem. It is going to have to be worked out locally, by people like yourself, in community after community across the nation.

How long has it been since you stepped inside your children's schools, and how can you know what's going on unless you look for yourselves?

When discussing these problems with President Eisenhower just before the delightful ceremony of awarding him Honorary Membership in ASME he told about one of his experiences when he was President of Columbia University. Addressing a group of reasonably well-to-do parents on the subject of better teachers, and in stressing that our teachers have close contact with our children more hours per day than the average parent, he asked any parents to rise who had ever had their child's teacher as a guest in their home. Not one rose. The President then said that if their teachers were not recognized by the parents and the community as "first rate citizens" how could they hope to have good teachers.

All of us can take inspiration from the case of a young graduate whom we shall call Richard. He is 22 years old. He is a graduate of a great engineering institution which he attended with the help of a scholarship. Next fall he is going to start teaching physics at a mid-Western University. During the summer he is going to work at the new General Motors Institute. His total salary for the first year will be about $8000.

Out of that sum he is setting aside $1200 to establish a scholarship fund to help other students share his enthusiasm—these are his own words—for "the worth of an engineering education." He plans to continue the scholarship fund indefinitely, and has already made arrangements with the school's scholarship committee to administer the first awards.

This may not solve all of our problems, but this would be a better world if we had a few more Richards to help other students to appreciate the worth of a Case education, a Western Reserve education, a Fenn College education—really, to appreciate the worth of citizenship in this wonderful country.

It is proposed, therefore, that you do what you can to show *your* appreciation of the worth of your citizenship. You can do it by gifts of money. But if you cannot do it by means of money—and even if you can—it is further urged that you put at the disposal of your communities the one thing that you alone can give: the priceless advantage of your special training and experience in the engineering profession. You can do it by serving on official and semiofficial community organizations. You can do it by volunteer work in the educational system of your community. You can do it by taking an active interest in the way your children are being taught. Of course situations may vary in each of your communities. However, the chances are good that your schools could stand a lot of improvement.

Memo From the President

Look about you; see whether your schools are as good as they ought to be in order to teach your children and your neighbors' children. If they are not, and if you would like to know what you can do about it, please feel free to get in touch with me. And if they are as good as you think they can be, I certainly want to hear about *that*. You will be able to reach me at ASME headquarters in New York until the Annual Meeting. If we do get some action on this score, I will certainly feel that 1956 has been the biggest year yet.

The Challenge of Progress

The "thermal thicket" represents the present obstacle in air technology which science and engineering must overcome to safeguard peace

By R. C. Sebold

Vice-President—Engineering, Convair Division,
General Dynamics Corporation, San Diego, Calif.

There is probably no recent development which staggers our comprehension as much as the development of nuclear weapons. In one brief decade we have increased the destructive power that can be delivered by such a magnitude that we have had to change our entire concept of warfare.

If we think about this tremendous increase in destructive power and visualize the effect it has on our weapons systems, we could come to the conclusion that our plans should be entirely based on the use of this weapon. This is only partially true. We must exploit this development to a maximum degree and then hope and pray that no one is foolish enough to start a war with these weapons. If we can convince our potential enemies of the force of our ability to retaliate, we have not expended our effort in vain. We must, however, look at the other side of the coin. Whether we think there will or will not be periphery wars in the future, such as Korea, we cannot afford to be unprepared to fight that kind of war.

Military-Aircraft Types

Fighters, interceptors, and fighter bombers have their place in both concepts. This is particularly true because the weapon which possesses this destructive power can now be carried on these types of aircraft.

The fighter is a weapon designed primarily for high speed and high maneuverability for air-to-air combat mainly with other fighters. It is primarily effective in periphery wars.

The interceptor is a weapon designed exclusively to destroy attacking bombers. It must be capable of carrying out its mission day or night and in any kind of weather. To accomplish its mission, it must carry search radar and fire-control equipment to make the attack and, in addition, must carry the equipment required for ground control. It might be aptly named a bomber-destroyer.

The fighter bomber has been conventionally regarded as a weapon of offense on and near the battle field. Fighters and interceptors have been converted into fighter bombers by adding external stores, such as rockets, napalm, and small weapons. In modern interceptors, such as the F-102, these stores can be carried internally without adding additional drag to the aircraft. The capability of carrying nuclear weapons transforms the fighter bomber into a formidable threat and thus these types also have capabilities in both a nuclear or a TNT war concept.

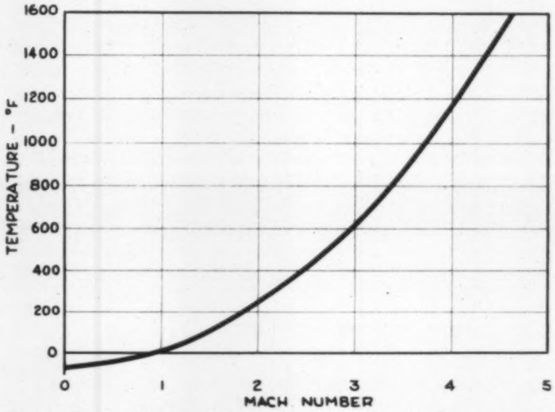

Fig. 1 Rise of stagnation temperature with increase in Mach number

The Interceptor. Now let us examine the interceptor a little more carefully and what is required of it. It cannot pick the altitude or speed at which it must operate. It must be capable of making a successful attack on an enemy bomber. Thus the speed and altitude of the bomber determine where and how the interceptor must operate. This means interceptors must have the maximum flexibility in performance—both in altitude and speed to permit successful attacks.

Before examining what increase in altitude and speed means to an interceptor, let us look for a moment at our progress in these areas with manned vehicles. In World War II bombers flew at an altitude of 30,000 ft, or higher if they could, in the target area. Before World War II, altitude was not considered a prime factor. Since that time, progress has been made in increasing the altitude of bombers, but it has not been spectacular.

Our progress in increasing speed has been more spectacular. In the past 10 years we have made approximately twice as much progress as was made in the previous 40 years.

The Thermal Thicket

Why do we keep pushing speed when it increases our problems? For example, if we look at Fig. 1, we see the increase of stagnation temperature with increase in Mach number above 35,000 ft. It will be noted that at Mach 1 it is only 10 deg; at Mach 2 it is about 250

Contributed by the Aviation Division and presented at the Aviation Conference, Los Angeles, Calif., March 14–16, 1956, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 56—AV-19.

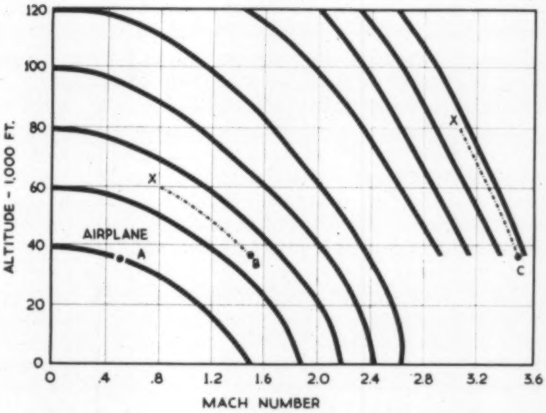

Fig. 2 Lines of constant energy in which potential and kinetic energy are exchanged

deg, which is a good temperature for cooking beef; at Mach 4 it has increased to 1200 deg; and at Mach 5 it is well over 1600 F. These figures show that we are wading into the thermal thicket and that it has defense in depth against our efforts to invade it.

Now, in the case of the interceptor, let us look at one of the reasons why we do this. There is a very fundamental relationship between speed and altitude which increases in importance as interceptor speeds increase. This relationship is not only common to all interceptors, it applies to all vehicles in motion and it is one of the most elementary relationships in our physics books. It is simply this...kinetic energy can be converted into potential energy and vice versa. In the past we have become accustomed to thinking of airplane performance in terms of classical performance charts. On these charts the absolute ceiling is regarded as an asymptotic goal. The service ceiling was defined as the altitude where the aircraft still had a classical rate of climb of 100 fpm. The performance was in equilibrium. The aircraft could maintain that altitude as long as it functioned properly.

The Element of Speed. Now let us see where increase in speed comes into the picture. Fig. 2 is a plot showing lines of constant energy in which potential and kinetic energy are exchanged. As a convenience, these lines have been plotted against Mach number. This explains the unexpected shape of the curves under 35,000 ft—as the standard temperature varies below this altitude.

It is not the intent to show the specific effect on any given airplane, but only to indicate the effect of kinetic energy on airplanes in general, and, therefore, airplane drag and engine thrust have not been interjected into the picture, although the increase in engine thrust at high speeds is an important factor.

For the purpose of illustration, however, assume that an airplane would follow these paths. Consider airplane A, traveling at 0.5 Mach number at 35,000 ft. The maximum exchange of kinetic-potential energy is 5000 ft and the airplane speed would be zero—not practical. Now let us look at airplane B, traveling at Mach 1.5 at 35,000 ft. If this airplane exchanged speed for altitude, it could zoom to 60,000 ft and still have a speed of 0.9 Mach number.

Now let us consider airplane C, traveling at a speed of 3.5 Mach at 35,000 ft. If we again exchange speed for altitude, we could zoom to 80,000 ft and still be flying at a Mach number of 3. This airplane also could maintain this altitude while decelerating and operate normally.

Now the figures just mentioned do not represent what an airplane actually would do since drag and thrust have been neglected. However, the relative importance of speed is clearly indicated.

Aircraft Materials

The most common structural material used in aircraft to date has been aluminum alloy. If we look at Fig. 3, we see that the useful range for aluminum-alloy structure cannot be pushed much beyond Mach 2. Titanium has been heralded as a substitute for aluminum alloy for higher temperature; titanium can carry us only from Mach 2 to approximately Mach 3. The next material we may use is steel, which loses its useful properties at slightly above Mach 3.5.

It is apparent that the game of substitution is almost played out at this point. We may be able to add to the life of our current structural materials by insulation of load-carrying structure from the temperature sources, or by strategic refrigeration. Specialized applications such as sintered ceramets also show promise. While these solutions may not be scientifically difficult, the engineering problems which they pose are most discouraging.

Science Called on for Answers. It is apparent from this brief discussion that the need for fundamental knowledge enters more and more into our task of solving our problems, or, conversely, it might be stated that this rapid acceleration in our developmental achievements has thrust us closer to the boundary of our scientific knowledge. There is urgent need for fundamental studies of heat transfer—both from gases to solids and within solids, studies of the nuclear bond within solids, and studies of why the effects of temperature bring about the loss of structural strength. We must, therefore, call on science to provide us with additional tools.

Problems of Stability and Control. Solving the problems of actually constructing an airframe does not leave us a clear field. There is another area into which we have been moving at a steady rate, but for which a fresh

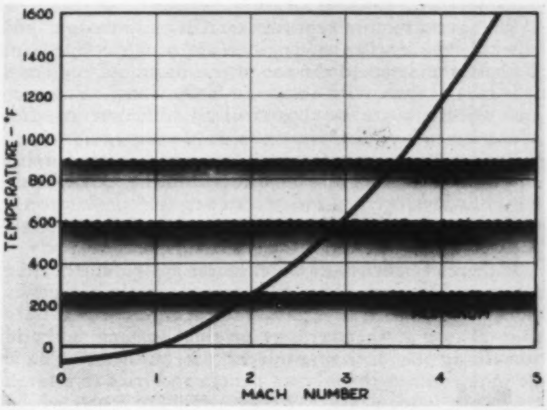

Fig. 3 Useful ranges of structural materials in relation to Mach number

approach may be required to maintain our progress. This is the area of stability and control. A good deal of attention has been given to this subject outside of the earth's atmosphere, but the intervening area has suffered—perhaps from a lack of glamour.

In the thin atmosphere at high altitudes, the airplane mass is very great in comparison to its surrounding atmosphere and the problem approaches that of outer space. Either lower control effectiveness or sluggish response must be accepted or other special means must be used to accomplish maneuvers. By the same token, a motion once established is difficult to arrest and the damping forces are discouragingly small.

In the present crop of fighters and interceptors, sometimes called the century series, we have run into problems which we did not entirely anticipate.

One of these is the so-called JC maneuver. This is a pitching oscillation, pilot-induced, and, once induced, cannot be controlled by the pilot. Another is the result of our designs having low-aspect-ratio wings with large masses of fuel and engine located in the fuselage. This has changed the inertia relationship of the airplane and has brought about inertia couplings which have given us no few headaches.

Before we launch into more complex compensators, there is need for more fundamental thought on how to obtain adequate stability and control with reduced complexities. This approach may be in the direction of more complete automation with computers to compensate for widely varying conditions.

Manned Aircraft or Missiles? Whether we accomplish our task with manned aircraft or missiles, our job is not easy. As long as it is practical, we will continue to go forward with manned aircraft as well as missiles. We have not yet proved that we can do without man's judgment. It is an understandable fact that policy levels of the armed services could have grave reservations about meeting requirements of national security by the use of mechanical systems actually unproved and which may remain so short of war itself.

Recent history of the aircraft industry has shown a strong influx of physicists, mathematicians, chemists, and other basic scientists, to assist in the solution of the sort of problems that have been mentioned.

Scientists in Industry

We have a requirement for scientists in industry. We must blend scientists and engineers into an effective team. To better understand the use of scientists and engineers, it is best to start with some firm definitions. Engineers and scientists are not particularly different in their education today; this was not true 20 years ago.

Both are now educated in the scientific facts of nature and trained in exact mathematic methods. Both require a highly developed curiosity about the physical universe, properties of materials, mathematical formulations, and the working of machines and electrical circuits.

If then a scientist and an engineer are so much alike, what is different? The difference is in their motives. Consider two men of equivalent background and training; if one of them creates original systems or builds something new, he is an engineer. If, on the other hand, he inquires into the why of things and tries to relate it to known fundamental laws, or formulate problems that bear upon still unknown laws, he is a scientist.

Simply stated, given the same capabilities, the engineer desires to build something and make it go, and the scientist desires further explanation and discovery.

If we are to make the progress in the future, which we must make, we must learn properly to integrate the efforts of people in both of these fields.

Scientific Research. For scientific research within industry, we must provide adequate environment in which a man can think freely without the pressure of schedules and fire drills; and we must provide adequate management and guidance so that the results of his work will furnish the new tools required by the engineer to accomplish his task.

Many men, whose background has been scientific research, are now working in engineering areas. These men should not be separated into special groups or isolated in our engineering departments, but they must be made a part of the engineering operation and given proper responsibilities.

With the proper kind of understanding, we can and are blending engineering and science into the kind of team we require to solve our problems.

Operations Analysis and Weapons System

We in industry must do suitable operations analysis in conjunction with the military services to understand weapons-system requirements properly and best techniques for employing weapons. The concept of the weapons-system approach to development has also been the subject of a great deal of attention and we believe has been beneficial to our national defense program.

The terms operations analysis and weapons systems are used often today and sometimes they mean different things to different people. As used by the author they may be defined as follows:

A weapons system is the complete complex of trained men, tactics, weapons, and ground equipment, blended together in proper proportions to accomplish the objective of a system.

Operations analysis is the method of determining requirements and the best techniques for using all elements of a weapons system.

We do operations analysis in industry for two primary purposes: (1) To supply management with as much data as possible to aid in making executive decisions for long-range planning. (2) To work with the military services in order to assist them in the establishment of requirements for new weapons.

As the physical problems increase and we progress into more difficult areas, more and more attention must be given by the team of service and industry to the operations-analysis and the weapons-system approach. This attention is necessary not only to insure that the solution is comprehensively adequate, but to prevent overstatement of the problem and dissipation of talent in areas which do not contribute directly to the mission of the weapon.

The Future. Progress in the future has challenged us. The destructive power of weapons has increased almost beyond imagination. As our weapons for defense and retaliation against such weapons become more complicated, the "thorns" in all of the "thickets" become increasingly sharper and we push the limits of our physical knowledge. We must combine all of our engineering, scientific, and management talents toward moving safely through the thicket, to the peace we all want for our families and our nation.

The Liquid-Metal-Fuel Reactor Closed-Cycle Gas-Turbine Power Plant[1]

Inert gas as working fluid makes high thermal efficiency possible

By L. D. Stoughton[2] and T. V. Sheehan[3]

Brookhaven National Laboratory, Upton, Long Island, N. Y.

The concept of the gas-cooled reactor has been familiar to the nuclear-energy field since the first reactors were constructed. However, these early reactors were primarily for research purposes or production of fissionable materials and not intended for the production of power. Atmospheric air or other low-pressure gases were often used or proposed as reactor coolants. The resultant high pumping power, low heat-transfer rates, and temperature limitations resulting from corrosion by atmospheric air left something to be desired from the standpoint of the power industry.

As a result of advances in the art of fabrication techniques for reactor-fuel elements, there now exist some promising types of high-temperature solid-fuel elements. When these elements are used to heat an inert gas, corrosion problems are greatly reduced if not eliminated entirely. The thermodynamic performance of the reactor core can be enhanced by using heat-transfer passages of small hydraulic radius and by raising the gas pressure. This will give higher heat-transfer rates at a lower pumping power. Furthermore, if a satisfactory barrier can be maintained between the reactor fuel and the reactor coolant, then this heated gas can be used directly in a gas-turbine cycle.

Nuclear-Power-Plant Proposals

Current interest in the nuclear gas-turbine power plant is shown by a number of recent proposals. The Gas and Electric Department of the City of Holyoke, Mass., has proposed the construction of a 15,000-kw closed-cycle gas-turbine power plant with a solid-fuel-element nuclear reactor as the heat source (1).[4] This proposal is part of the Atomic Energy Commission's Power Reactor Demonstration Program. Nine concerns, including the American Turbine Corporation, AMF Atomics, Atomics International, Ford Instrument Company, General Atomics, General Electric, Cleveland Diesel Engine Division of General Motors, Nuclear Development Corporation of America, and the Pacific Coast Nuclear Power Group have recently submitted proposals to the Maritime Commission for the development of a nuclear gas-turbine power plant for merchant vessels (2).

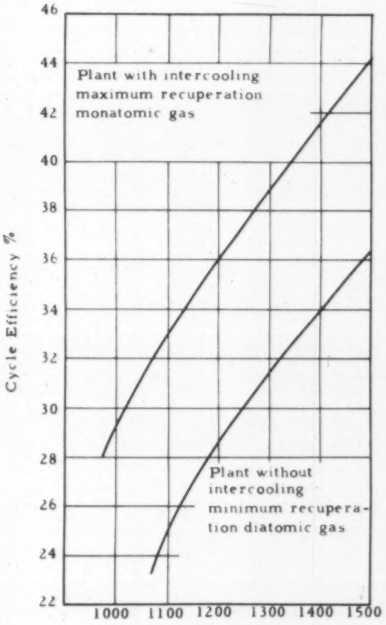

Fig. 1 Range of closed-cycle gas-turbine efficiencies

The purpose of this paper is to present the concept of a nuclear power plant which combines the advantages of a liquid-metal-fueled reactor with those inherent in a closed-cycle gas turbine. Extensive development work on the closed-cycle gas turbine has been carried on by the Escher Wyss Engineering Works of Zurich, Switzerland. Progress in this work has been periodically reported to the ASME by Dr. Curt Keller of Escher Wyss (3, 4, 5).

The major advantages of the closed-cycle system result from its ability to use a clean, inert, high-pressure gas as the working fluid. Turbomachinery sizes for units up to 200,000 kw net output remain within practical limits because turbine exhaust is at a relatively high pressure. Fluid passageways of small hydraulic diameter can be realized through the use of the clean, dry, and inert work-

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[1] This paper is based on a study by a group at Brookhaven National Laboratory which also included W. A. Robba, now with Raytheon Manufacturing Company, H. L. Falkenberry of the Tennessee Valley Authority, and C. J. Raseman.

[2] Mechanical Engineering Division, Brookhaven National Laboratory, Upton, N. Y. Assoc. Mem. ASME.

[3] Mechanical Engineering Division, Brookhaven National Laboratory, Upton, N. Y. Mem. ASME.

[4] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Gas Turbine Power Division and presented at the Gas Turbine Power Conference, Washington, D. C., April 16–17, 1956, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 56—GTP-12.

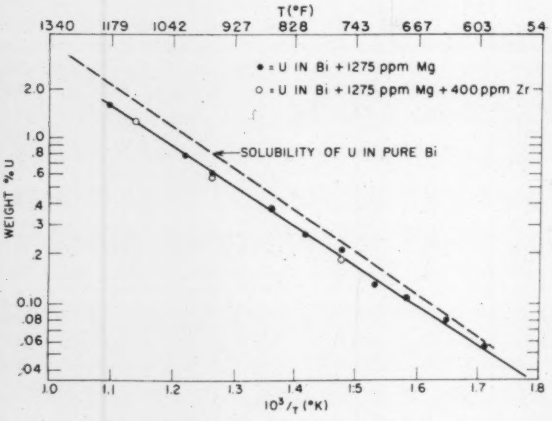

Fig. 2 Solubility of uranium in bismuth versus temperature

ing fluid, resulting in compact arrangements for the recuperator, precooler, and intercooler. Output can be varied by changing pressure level which results in good part-load efficiency. Gas is added or removed from the system through apparatus located in the low-temperature portion of the cycle. Cooling-water requirements are reduced because of sensible-heat rejection from the system instead of latent-heat rejection.

The closed-cycle turbine can utilize higher-temperature materials efficiently as they become available because of the absence of corrosion and deposition problems. Fig. 1 (6) shows the thermal efficiencies that can be obtained with turbine-inlet temperatures in the range 1100 to 1500 F. The liquid-metal fuel which is under study at the Brookhaven National Laboratory (BNL) is a potential high-temperature heat source for this closed-cycle gas-turbine system.

Liquid-Metal Fuel

This reactor fuel is being developed by the Nuclear Engineering Department at BNL for use in the liquid-metal-fuel reactor (LMFR). The LMFR is currently designed to produce 900 to 975 F steam for a central-station power plant with a rating of 200,000 kw and it will be capable of breeding as much fissionable material as it consumes (7).

The reactor fuel is a solution of uranium dissolved in molten bismuth. Bismuth is one of the heavy metals, melting at 520 F and having a density of 600 pcf at 1200 F. It has a boiling point at atmospheric pressure of 2691 F which makes it suitable for high-temperature applications without necessarily requiring high pressure. Its low absorption cross section for thermal neutrons (0.032 barns) results in good neutron economy for the reactor core. Fig. 2 shows the solubility of uranium in bismuth as a function of temperature, and includes the effect of magnesium and zirconium which are added to inhibit corrosion. Most of the reactor cores considered at BNL have critical uranium concentrations which are well within the solubility limits.

There are certain outstanding features of uranium bismuth when it is used as a liquid reactor fuel:

1 It can be circulated through the core at a sufficient rate to carry the heat generated in the reactor core to an external heat exchanger. This means that core-design parameters need not include heat-transfer surface.

2 It is not subject to radiation damage, which is a factor that seriously influences the usable life of a solid-fuel element. However, bismuth will absorb some neutrons and form the dangerous element polonium, but this hazard is considered not greater than that caused by the presence of fission products.

3 It can be handled by pumping and does not require the handling mechanisms and removable closures used with solid-fuel-element systems.

4 It can be processed continually; that is, fission products can be continuously removed from the system and fresh fuel added at a rate to compensate for the fuel consumed in the core.

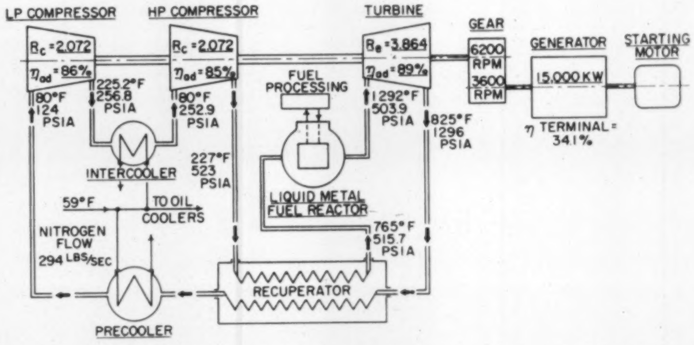

Fig. 3 15,000-kw liquid-metal-fuel-reactor closed-cycle gas-turbine power plant

5 There is no limit on fuel burnup which means that large quantities of unspent fuel are not required to be reprocessed.

6 Control mechanisms are not required because of the large negative temperature coefficient of reactivity which enables the reactor core to be self-compensating for load changes and because the continuous addition of new fuel requires no excess inventory of uranium to be held in the core.

When a liquid-metal-fuel reactor is used as a heat source for a closed-cycle gas-turbine power plant, there are two fundamental arrangements which may be employed:

Externally Cooled. The cycle working fluid is heated in an exchanger, located outside the reactor core, through which the fuel is circulated.

Internally Cooled. The cycle working fluid is heated directly in the reactor core, with the fuel remaining essentially stagnant.

To illustrate the application of the externally cooled and internally cooled arrangements, we have selected as a power plant a closed-cycle gas turbine which is being designed for production by Escher Wyss and is available through that concern or its licensees. This unit has a rated output of 15,000 kw. It is designed to operate with nitrogen as the cycle working fluid in order to take advantage of the extensive air-turbomachinery experience.

However, nitrogen will absorb a few of the thermal neutrons in a reactor core. The effect of pressure changes on reactivity and the presence of small amounts of radiocarbon (resulting from the capture of a neutron by a nitrogen atom) in the cycle working fluid remain to be assessed. Helium presents a more desirable choice because of its negligible thermal-neutron-absorption cross section and its excellent heat-transfer characteristics. Design of helium turbomachinery is currently being given serious consideration by Escher Wyss (5).

The cycle diagram is shown in Fig. 3. The gas is compressed from 124 psia to 256.8 psia in the first compressor, intercooled, and further compressed to 523 psia in the second compressor. After being heated to 765 F in the recuperator, the gas is further heated to 1292 F by the liquid-metal-fueled reactor. The gas then expands through a turbine which is mechanically coupled to the compressors and also drives the generator through a speed-reduction gear. The expanded gas gives up heat in the recuperator to the precompressed working fluid and returns through a precooler to the compressor inlet. The 15,000 kw is produced by a gas flow rate of 294 lb/sec at the pressure levels indicated in the foregoing. This cycle converts the nuclear energy into electrical energy at the generator terminals with an efficiency of 34.1 per cent.

Externally Cooled Reactor

The basic elements of an externally-cooled system include the reactor core where heat is generated in the uranium bismuth, a heat exchanger for transferring this heat to the cycle working fluid, and a pump for circulating the uranium-bismuth stream. As shown in Fig. 4, these elements can be contained in a single vessel which minimizes the uranium-bismuth inventory and somewhat simplifies the containment problem. Since the primary heat-transfer surface is not in the reactor core, the core design is relatively simple. A wide range of core sizes and compositions have been explored at BNL (8). This study included the three fissionable materials (U-233, U-235, and Pu-239), two moderators (graphite and beryllium), and a number of moderator-to-fuel ratios which included an externally moderated case (i.e., no moderator in the core, neutrons causing fission having been moderated in the reflector before returning to the core). The resulting core sizes ranged down to nearly 1 ft diam but for these very small cores, the fuel concentrations exceed the solubility limits and would require the use of slurry fuels which are also under development at BNL (9).

The 15,000-kw gas-turbine system will require a heat-generation rate of 150,000,000 Btu/hr. A total of 2500 gpm of bismuth containing 1500 ppm of uranium in solution enters the reactor core at 1200 F and is heated to 1500 F. The core is a $3^1/_2$-ft right cylinder of graphite with holes for the uranium-bismuth solution amounting to 50 per cent of the core volume. About 250 gpm of the fuel solution would by-pass the core and remove the heat generated in the 3-ft reflector. The 1500 F U-Bi then passes through the shell side of a tube-and-shell heat exchanger. The power-plant working fluid is heated to 1292 F as it passes through the tube side. The U-Bi is circulated back through the core by an axial-flow pump. This equipment is arranged in a single pressure vessel which is filled with graphite. The heat exchangers and pump are located in wells and can be removed by disconnecting flanges on the top head of the vessel. The pump can be driven by an electric motor or a turbine using the power-plant working fluid. U-Bi flows through passageways in the graphite. Volatile fission products can be removed from the free bismuth surface between the exchangers and the pump. About $^1/_2$ gpm of U-Bi is continuously circulated through a processing plant which is located outside the vessel. Fission products are removed by contacting this U-Bi stream with a molten eutectic of certain chloride salts, a method which is currently being developed by BNL. Fresh uranium is then added to the U-Bi and the processed stream is returned to the core.

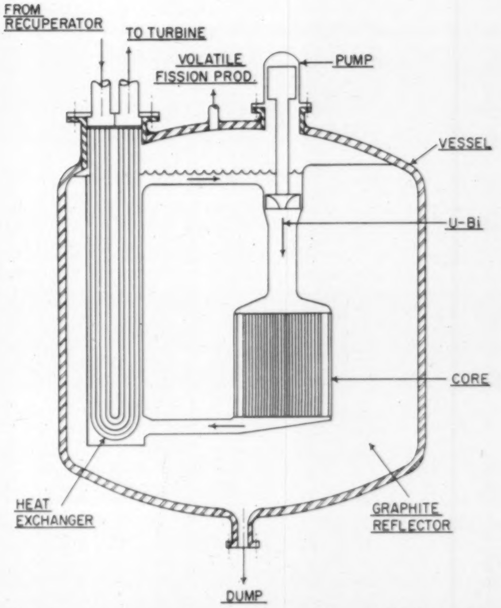

Fig. 4 An externally cooled liquid-metal-fuel reactor

Internally Cooled Reactor

In the internally-cooled arrangement, the liquid fuel can be used as a "fixed" fuel element. The total uranium-bismuth inventory is reduced because the liquid fuel is not circulated through an external heat exchanger. The high-temperature fuel is confined to the reactor core. Since the power-plant working fluid may be heated directly in the core for optimum performance, the moderator could best act as the barrier between the fuel and the gas. Either graphite or beryllium would be suitable moderators for an LMFR core but to date most of the development work at BNL on moderator materials has been done on graphite.

For the gas-turbine application, the reactor core could be assembled from a number of 1-ft cubical graphite blocks, each drilled with a set of vertical holes and a set of horizontal holes. A segment of a block is shown in Fig. 5. The uranium- bismuth fuel is contained in the vertical holes and the power-plant working fluid is heated as it passes through the horizontal holes. Four blocks are cemented together with vertical fuel holes in alignment and sixteen of these groups are stacked together to form the 4-ft-cube reactor core as shown in Fig. 6. The liquid fuel can be circulated through the core at a low rate sufficient for processing via graphite tail pieces cemented to the ends of each group of blocks. One end of each tail piece is cored and cemented to the group of graphite blocks in order to gather and distribute the fuel. A graphite-to-metal tube joint is made at the outer end of each tail piece so that the fuel can enter and leave the reactor vessel through metal tubes.

The core can be surrounded by either a reflector or a breeding blanket, depending upon the application. For breeding applications, cross-drilled graphite blocks similar to the core subassemblies would be used. Thorium-bismuth slurry, which is being developed by BNL as a breeder fluid, would be in vertical holes. A portion of the power-plant working fluid would be diverted through appropriate horizontal holes, whether or not the reflector contained breeding fluid.

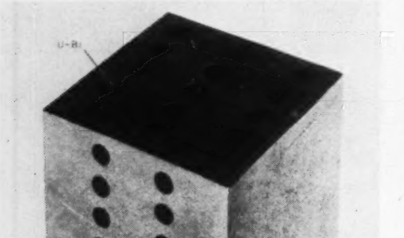

Fig. 5 Section of a graphite core block

Materials of Construction

The success of a liquid-metal-fueled reactor as the heat source for a closed-cycle gas-turbine power plant will depend primarily on the development of a suitable container material for uranium bismuth at the required temperatures. In both the internally-cooled and externally-cooled arrangement, the container material must not react with the uranium bismuth and it must prevent diffusion of fission products into the power-plant working fluid.

Brookhaven is currently developing container materials for use at 1050 F in the steam plant mentioned previously. In addition to uranium, there are several metals which are soluble in bismuth. They range from iron at a few ppm to nickel, copper, aluminum, and magnesium at several per cent. Materials which appear to be practically insoluble in bismuth are beryllium, molybdenum, niobium, tantalum, and tungsten. It has been found that the addition of soluble inhibitors, such as zirconium, to a uranium-bismuth low-alloy-steel system at 1050 F can prevent corrosion by forming a protective zirconium nitride layer on the steel. Work on uranium-bismuth-graphite systems at 1800 F has shown that zirconium also forms a layer of zirconium carbide on graphite to prevent reaction between uranium and carbon.

For the externally cooled arrangement we do not yet know whether the inhibiting layer will be satisfactory on a heat-exchanger-tube material that has good mechanical properties at 1500 F. An alternative approach may be cladding the bismuth side of the tubes with one of the insoluble metals such as molybdenum or tantalum. In the internally-cooled arrangement, it has not yet been determined whether graphite will prevent the diffusion of fission products from uranium bismuth into the gas. It is hoped that certain surface-impregnation techniques will effectively prevent fission-product diffusion.

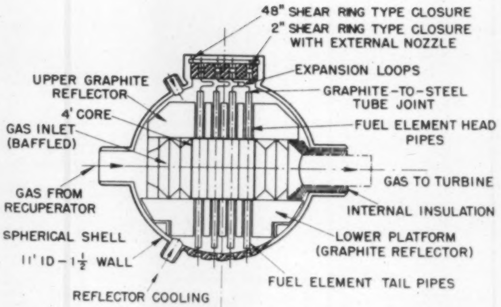

Fig. 6 An internally cooled liquid-metal-fuel reactor

Advantages

The potential advantage of the nuclear power plant described herein is in the combination of a promising nuclear heat source with the closed-cycle gas turbine. The closed-cycle gas-turbine unit will be capable of high-temperature operation, and therefore will have a high thermal efficiency, through the use of an inert-gas working fluid. Equipment size will be moderate because of the elevated-pressure levels. The liquid-metal-fuel reactor offers a promising high-temperature heat source for the closed-cycle gas turbine, pending the development of suitable container materials for the fuel. The present effort on LMFR at the Brookhaven National Laboratory is on the fundamental problems of the uranium-bismuth fuel as applied to a steam-turbine system. However, there will be some common areas in which useful information for the gas-turbine system also should be obtained.

It is our hope that the LMFR closed-cycle gas-turbine power plant will be sufficiently attractive to those interested in the nuclear-power field to warrant further study.

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Bearings, Lubricants, and Lubrication

—A Digest of 1955 Literature[1,]

Journal Bearings

Analysis. Complete solutions of Reynolds two-dimensional equations were obtained by Walter and Sassenfeld (1)[3] using a modernized Gauss-Alogarithm and by Pinkus (2) using a digital computer. The first paper deals with 360 and 180-deg bearings for both parallel and misaligned shafts. The second paper presents solutions for circular and elliptical bearings, the latter containing "ellipticity" as a variable parameter. The papers cover eccentricities up to 0.95 and L/D ratios down to $^1/_8$.

An approximate solution of Reynolds equation for the case of an infinitely short bearing was obtained by DuBois and Ocvirk (3). The solution contains the L/D ratio as a parameter and thus can be used for short bearings of any size. Further one-dimensional solutions of Reynolds equation were obtained by Shawki (4) for a bearing operating under a variable load. This paper is accompanied by another experimental study (5) of a dynamic load superimposed on a stationary vertical load. Lee (6) obtained solutions for infinitely long, partial journal bearings with bearing arc and direction of load as variables; the centrally located load vector is treated as a special case.

An attempt to solve Reynolds equation analytically was undertaken by Fedor (7). The solution offered is derived under the assumption of an insignificant change in the oil-film thickness which gives validity to the results up to eccentricities of about 0.4.

The significance of the inertia term in the original Navier-Stokes equation as applied to hydrodynamic lubrication is analyzed by Brand (8). It is shown that if the Reynolds number is of the order of Radius/(Radial clearance), then the inertia forces will be of the same order of magnitude as the viscous forces. The dynamics of squeeze films and the time element involved were analyzed by Archibald (9). The performance of starved bearings is considered by Wilcock (10); this investigation also considers the time lag between oil supply cutoff and bearing failure.

Two papers were offered on the temperature distribution in journal bearings. Pinkus and Sternlicht (11) give expressions for the circumferential temperature-distribution profile in the mid-section of a bearing as a function of angle along with bearing dimensions and operating conditions as parameters. Purvis, Meyer, and Benton (12) offer solutions for both infinitely short and infinitely long bearings.

Stability. The problem of shaft vibration in fluid-film bearings received attention in several papers. Newkirk (13) in a review paper attempted to classify the several manifestations of shaft vibration and establish an acceptable terminology for shaft instability.

A paper by Sternlicht (14) deals with halfrunning frequency whirl and the design of stable bearings. Pinkus (15) deals with the phenomenon of resonant whip, and the effect of bearing design and operating conditions on shaft stability. Shawki (16) presents results on the initiation, persistence, and damping of both steady and transient whirl under conditions approaching zero load.

An analytical study of oil whirl in journal bearings is given by Cameron (17). Depending on the assumptions made either a vibration similar to half-running frequency whirl is obtained or one that is a modification of the results obtained by Hummel, which are discussed by Cameron.

Hagg and Sankey (18) describe experiments dealing with unbalance vibration and critical speeds as affected by the dynamics of the oil film in bearings.

Experimental Data. Tests on misaligned journal bearings were run by Ocvirk (19) and by DuBois, Ocvirk, and Wehe (20). Pressure plateaus are drawn for various conditions of shaft misalignment. Barwell, Milne, and Webber (21) tested 2-in. bearings under variable load and frequency; their studies led them to the introduction of special grooving. The minimum oil-feed rate for complete oil films was investigated by Fuller and Sternlicht (22) who present the rate requirement as a function of operating conditions. The extent of the oil film in complete journal bearings is given by Cole and Hughes (23). Photographic records of the extent of full and partial films are provided. The bearings also were run under misaligned conditions. Bearing operation with extremely thin oil films is described in a paper by Kreisle (24). Effects of grooving, foaming, and starting under load are discussed.

Design Data. A number of papers of a general nature were offered on the design of sleeve bearings. Bidwell (25) scans the whole field of bearing application from proper grooving to effect of sulphur on bearing material. Hersey (26) reviews the requirements of full fluid-film lubrication as distinguished from boundary lubrication. Pinkus (27) provides the designer with means of selecting bearing parameters properly and operating conditions to meet requirements of load capacity, temperature rise, and instability. Leloup (28, 29) presents ways of calculating bearing performance, particularly bearing friction. Gerard (30) after a general review of the field of hydrodynamics, discusses applications in various machines. Sternlicht (31) discusses six methods of lubricating sleeve bearings including ring and wick lubrication.

Bearing Materials. A wide range of materials from cast iron to teflon and wood are considered as possible materials for sleeve bearings. Lunn (32) discusses the so-called Beilby layer originating from mechanical polishing. Brewer (33) surveys the advantages and

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[1] Report prepared by H. A. Hartung with the assistance of the Research Committee of the ASME Lubrication Division. Contributors were: O. Pinkus, B. Sternlicht, S. J. Beaubien, N. H. G. Daniels, C. M. Larson, P. Skerchock, and H. A. Hartung. The summary for the year 1955 was based principally on the Engineering Index references on Bearings and Lubrication.

[2] The "Digest of 1954 Literature" appeared in MECHANICAL ENGINEERING, vol. 77, September, 1955, pp. 789–801.

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

limitations of rubber, aluminum and silver alloys, graphitar, nylon, and phenolic-base materials. Love, Forrester, and Burke (34) also discuss various materials while Blanderer (35), in addition to the familiar tin and lead-base alloys, deals with white metal and lead bronze. Brand and Davis (36) consider the problem of thermal expansion, thermal conductivity, and accompanying stresses in plastics, particularly nylon. Migny (37) discusses some special bearings having an outside coating of graphited rilsan or nylon. Nudelman and Sump (38) consider porous stainless bearings impregnated with teflon for application in water-lubricated bearings. Mitchell and Burke (39) suggest impregnation of porous bearings with polyfluorethylene. DeSantos (40) gives properties of porous bronze bushings sintered in a vacuum. Mohler (41) has a discussion of babbitt, copper-lead, leaded bronze, and silver. Aluminum bearings are treated in three papers by Mohler (42), Wood (43), and Vaders (44). Mohler (45) also discusses the characteristics and application of bearings overlaid with tin or lead alloys.

Special Subjects. The phenomenon of turbulence is treated theoretically and experimentally by Smith and Fuller (46). Comparison of load-carrying capacity, horsepower, and eccentricity locus is made between turbulent and laminar flow. Factors affecting design of automotive bearings are treated in a paper by Campbell (47); consideration is given to lubricating systems. Freon-lubricated compressor bearings are discussed by Lippschuetz (48). Influence of miscibility of Freon-12 with oil is considered.

Thrust Bearings

Hydrodynamic analysis of slider bearings under the assumption of an exponential oil film continued in two papers by Osterle and Saibel. One of the papers deals with the load-carrying capacity of a spring-supported bearing (49) and the other considers grease as a lubricant (50). Raimondi and Boyd (51) analyze and discuss the centrally pivoted pad bearing with a nonhorizontal pad profile.

Performance data on thrust bearings were compiled by several workers. A paper by Neyman (52) presents methods for design of thrust bearings for hydroelectric-power generators. Baudry and Winer (53) discuss thrust-bearing design and performance for electrical machines. Mention is made of bearing currents. Wepfer (54) tested journal and thrust bearings using water as a lubricant. Ceramics, tungsten carbide, stellites, carbon graphites, and other materials were evaluated in this developmental program and the results are reported. Kettleborough (55) presents experimental results of film thickness, coefficient of friction, and oil-film pressure measurements for parallel-plate thrust bearings.

Hydrostatic Bearings

Raimondi and Boyd (56) analyzed orifice and capillary-compensated hydrostatic journal bearings. Hughes and Osterle (57) have calculated the performance of hydrostatic thrust bearings under adiabatic-flow conditions for both incompressible (oil) and a compressible (air) lubricant. Comparison with the isothermal case is given. Grinnell and Richardson (58) discuss design of orifice compensation in gas-lubricated bearings.

Boundary Lubrication

Several interesting reviews of this field have been written. Among these is one by Goettner (59) wherein the pertinent literature for the past 250 years is critically discussed, and many observations on surface characteristics, crystal lattice, Beilby layer, oxide films, and adsorbed layers are considered in detail. Blok (60) gives an excellent unifying treatment of the main aspects of dissipation of frictional heat which includes descriptive reasoning but leaves rigorous mathematical treatment to references. Both solid and fluid friction and the dissipation of heat in the immediate vicinity of the source are treated. A condensed review of the current weld, interlock-weld, asperity, and molecular theories of metallic friction is given by Koenigsberg and Johnson (61) together with a particularly timely discussion of the agreement between available data and the various theories. Fuller (62) presents a survey of mixed-friction lubrication (boundary and hydrodynamic).

Plasticine models have been used by Green (63) to observe the deformation of individual asperity junctions in a study of the friction between unlubricated metals. The analysis is confined to speeds so slow that surface heating is negligible; work hardening and ploughing are neglected. The models show that the less ductile the metal, the smaller is the strain before fracture, and with an early fracture the normal component of force increases faster than the tangential component. Hence brittle materials have a low coefficient of friction (μ). If fracture takes place at an asperity interface (weak junction) ductility has no effect. The character of freshly cut metal surfaces is being investigated by the Mechanical Engineering Research Laboratory (64) in England. They found that the previously reported particles which originate from a fresh surface and activate a Geiger-Muller counter are actually oxygen molecules that have picked up electrons at or near the abraded surface. This information may be particularly significant in terms of the work of Grunberg, 1953, who showed that, when metal was cut in the presence of water and oxygen, hydrogen peroxide is formed.

Daniels and West (65) used a low-speed (0.00005 to 0.1 cm/sec) pin-and-disk machine in controlled atmospheres to study the effect of moisture on friction and surface damage. They postulate that moisture accelerates the oxidation of surfaces exposed by deformation of the contacting asperities and that oxide or hydrate junctions therefore replace the normal metal-to-metal junctions. Friction is then determined by the properties of the oxidation products together with those of the underlying metal. Quantitative data for a number of metals are given. Ling and Saibel (66) propose a new criterion for the onset of gross metal transfer and surface damage. Starting with Blok's solution for the temperature of contact during sliding, they assert that galling will occur when the contact temperature equals the recrystallization temperature. Thus a relationship is established which relates galling to load, velocity, and time. Odier (67) made a theoretical analysis, based on classical heat laws, of surface temperatures to be expected during the sliding of unlubricated surfaces. The solutions were compared with results obtained with a lead-sulphide-cell pyrometer having a nearly instantaneous response. The observed temperatures generally agreed with theory but were characterized by rapid fluctuations as great as 100 deg C.

Feng (68) reasons that the total damage between contacting metals (i.e., metal transfer plus wear) is not a function of the thickness of the metal-oxide-adsorbed gas-surface film as long as the film is less than the depth of plastic roughening of the asperities (critical thickness). However, the distribution between wear and transfer is a function of the film thickness. Later Feng and Chang (69) varied the film thickness on specimens by varying the vapor pressure of water or alcohol in a closed system. Wear increased with film thickness up to the critical value (transfer decreased correspondingly) and then decreased almost to zero. Goodzeit, Roach, and Hunnicutt (70) measured the friction and surface damage for iron sliding on elemental metals and found that surface-damage characteristics are related to the hardness of the metals, their mutual solubility, and their ability to form intermetallic compounds. Johnson, Swikert, and Bisson (71) studied wear and surface damage in a pin-and-disk machine at speeds up to 18,000 fpm and temperatures up to 650 F. Emphasis was on materials used in bearing cages of aircraft turbine engines. Oxide films formed on cast Inconel, either naturally during sliding at high speeds or temperatures or by pretreatment markedly reduce wear and are self-healing but do not give low friction.

The influence of atmosphere on the sliding of relatively pure elemental metals has been found by Coffin (72) to be considerable. Oxygen markedly reduces friction and surface damage as compared to inert gases. Temperature and alloying tendency of the sliding metal pair also influence the process substantially. Strang (73) has attempted experimentally to separate the basic-wear process from corrosion by contaminants and abrasion by loose debris. A high-speed friction-and-wear machine is described by Clarke and Shugarts (74). Some results are given for copper sliding on dry steel at speeds up to 1200 fps.

Bowden (75) discusses recent studies by members of his group on metallic friction giving preliminary results of very high-speed friction (up to 2000 mph) obtained with a magnetically suspended and rotated ball. For clean steel on copper in a vacuum at low speed $\mu = 5.0$; at 1500 mph the contact points melt and $\mu = 0.2$. Otto (76) shows that the outer layers of rotating bands on artillery projectiles are recrystallized during firing. The hypothesis that the surface layer reaches a temperature approximately equal to the melting point is used to explain the high rate of recrystallization and the rapid decrease of μ at high sliding velocities. Data also were presented by Bowden (75) on metal transfer in engineering operations such as clamping, hammering, riveting, drilling, and screwing. Trace-metal transfer is important where impurities may cause local electrochemical corrosion leading to stress concentrations and possibly fatigue. In orthopedic devices metal transfer from tools to metal bone fasteners may cause adverse tissue reaction. Bowden also discussed work of Tabor on rolling friction wherein it was concluded that elastic hysteresis is the major component of friction and hence that, while lubricants may reduce wear, they cannot appreciably offset rolling friction.

The crossed-cylinder apparatus has been used to evaluate friction of plastics and wear of steel. Milz and Sargent (77), studying frictional characteristics of a number of plastics, found that the mechanical properties of teflon can be improved without sacrificing its low frictional characteristics. Under certain conditions, plastics run as well dry or with water as with oil lubrication. Twiss, Lewis, and Teague (78) examined the wear rate of steel as a function of surface roughness. They found that wear rate increases as original surface roughness increases. The type of lubricant used affects not only wear rate but the particle size and the damage to the steel surfaces.

Lunn (79) has evaluated the ability of bearing metals to form protective boundary films by reaction with mineral oil and the atmosphere. The electrical conductivity between a reciprocating steel ball and the test metal was measured and the area of the curve of conductivity versus time was found to be a reliable index of the anti-score value of a metal-lubricant combination. Babbitt metals, copper alloys, aluminum alloys, and cast iron were evaluated with mineral oil under boundary conditions, and some data on the effect of additives on babbitts are given.

The nature of the EP film formed on steel gears during operation with a sulphur-containing oil was explored by Borsoff and Wagner (80) who used radioactive dibenzyl disulphide to detect and measure the film. They found that its thickness increased with load but was not affected by time of operation. Since the film was thinnest at the pitch circle (zero sliding), it appears that temperature is the controlling factor. The maximum thickness was less than the 20-microinch (rms) finish of the gear surfaces.

Silicone fluids merit consideration for aircraft turbine engines because of their high-temperature chemical stability and excellent viscosity-temperature properties. They are extremely poor boundary lubricants for steel surfaces, and Murray and Johnson (81) have studied ways to improve lubrication through the use of chemically active additives. They hypothesize that silicones prevent the normally available oxygen from reacting with the surface to form the oxide films necessary for good boundary lubrication and they show by experiment that a peroxide additive improves the lubrication of steel by silicones. Murray, Johnson, and Swikert (82) also studied the use of difluorodichloromethane as a boundary lubricant for high-temperature service and found that some metals, e.g., modified H-monel sliding on hard tool steel, gave good results, whereas others such as silver or austenitic stainless steel were not lubricated by difluorodichloromethane. Although successful lubrication is possible, the authors emphasize that sensitivity to moisture and break-in need more study before practical application.

Difficulties with fluid lubricants at high temperature has focused attention on solid lubricants. Peterson and Johnson (83) show that lubrication effectiveness can be attributed more to the formation of an adherent film than to a particular crystal structure. They also show that humidity, liquid water or oil, and other factors influence the formation of adherent films so that μ may vary by a factor of 20 depending on the conditions of operation. Spengler (84) discusses experiments with MoS_2 at high temperatures and high sliding velocities and gives data for a number of applications such as plastics impregnated with MoS_2 phosphate-treated steel surfaces impregnated with MoS_2 and sintered Cu-Ag-MoS_2 mixtures. The data are followed by a discussion of suitable liquid carriers. Weismantel (85) has studied solid-film lubricants for ability to prevent fretting. He concludes that dry unbonded films such as graphite or MoS_2 are effective in delaying the start of fretting corrosion but that complex bonding vehicles, which are sometimes used in conjunction with the films, do not in themselves contribute to fretting protection.

Fretting of steel in the presence of mineral oil was studied by Godfrey (86). Wear particles are generated at a constant rate until they physically displace the oil from the contact area. Wear then occurs at an accelerated rate and brown oxidation products appear. A machine for measuring fretting damage under a wide variety of conditions is described by Uhlig and others (87).

Lane (88) considers mechanisms where high friction is desired but where seizure and overheating must be prevented. Data obtained on a two-ball machine for a number of petroleum-base stocks indicate that high-viscosity-index oils are the most efficient for friction-drive machines.

Nonmetallic wear was investigated by Huges and Spurr (89) who used wax sliding on cast iron and measured the rate of wear and the temperature of contact. After the temperature-hardness relation for the wax was established, wear was expressed as a function of load/hardness. Wenger (90) explored the use of laminated-plastic bearings and found that, with the low heat conductivity, water was necessary as a lubricant. Emulsified fats gave $\mu = 0.01$ for good operating conditions; however, dimensional instability may require a break-in after each period of shutdown.

Results of radioactive wear measurements are reported by Jackson and Miller (91) and Hundere, Lawrason, and O'Meara (92). In both studies information is given on piston-ring wear; the latter paper also contains data on gear wear.

Metalworking Lubrication

Metal Forming. Important advances in fundamental and practical knowledge of metalworking lubrication were presented during a symposium on metalworking oils convened by the Institute of Petroleum (93). Much of the work at Cambridge was summarized in an introductory paper by Bowden and Tabor (94) which described the cohesion theory of friction and discussed the importance of various adsorbed and chemically combined films with respect to frictional behavior. For example, both the coefficient of friction and the amount of pickup between sliding metals increases very markedly on heating as the lubricant film changes from solid to liquid and, at still higher temperatures where the film becomes desorbed, the friction and pickup are equivalent to those for the unlubricated state.

Ford (95) points out that the coefficients of friction measured in cold metal-forming processes such as rolling are lower than those in dynamic slider tests and are similar to those in plane compression "cigar" tests; however, from extensive cold-rolling tests he concludes that lubricants giving medium values for μ (0.06–0.08) are most desirable. Lubricants giving lower μ leave the strip dull and cause surface damage produced by the plucking out of small particles, while higher μ are associated with rough rolls and a bright torn surface. Some of Ford's work reported in (95) is described more fully by Whitton and Ford (96) and by Whitton (97); the back-tension method was here used to measure μ for many lubricants in the rolling of mild steel, copper, brass, and aluminum and also to provide a critical check of cold-rolling theory. Among several interesting contributions to the discussion (98) on the paper by Whitton and Ford, Wistreich suggests that the authors' results are compatible with quasi-hydrodynamic lubrication during metalworking.

The speed effect in the cold rolling of sheet, whereby the gage of the product is affected by variations of rolling speed, has become a major problem with the increase of mill speeds. Sims (99), who considers that lubrication in rolling is of the boundary type, suggests that the speed effect is due to the reduction of the time available for the extrusion of the lubricant and has performed rolling experiments with lubricant film thicknesses reduced by cleaning to support this explanation. In the discussion of this paper, Wistreich considers that Sims' results strongly support the view that the lubrication regime in rolling is quasi-hydrodynamic.

An investigation by Johnson, et al (100), to develop a substitute for palm oil in the rolling of tinplate showed that a modified beef tallow performed well in production mills. An extensive series of well-planned and informative tests was carried out to find the effect of such variables as lubricant type and composition, temperature, and surface preparation, using a slow-speed rod-drawing test. It is concluded that the oxide film on the metal, necessary for good lubrication, functions directly in the drawing operation, and its reaction with a fatty acid to form a soap is only secondary.

Kuntze and Pomp (101) compared three prelubrication treatments for the drawing of stainless-steel wire and showed that a lime dip, followed by a dip in concentrated common salt solution, provided a lubricant base as good or better than two commercial processes, with calcium stearate as lubricant.

Studies of the lubrication of wire-drawing by Ranger and Wistreich (102) and by Christopherson, et al (103), both include the measurement of electrical resistance between wire and die. The former authors conclude that the regime of lubrication in wire drawing at normal speeds is intermediate between boundary and fully hydrodynamic states and lubricating film thicknesses of 1000 to 30,000 A. Christopherson and his collaborators, making use of an extension tube at the die entry which enabled high pressures to be built up in the lubricating oil by the viscous drag of the wire through the tube, demonstrated that it was possible to establish full-fluid lubrication in wire drawing at speeds above 600 fpm. Tourret (104) considers that wire drawing generally involves a predominantly boundary type of lubrication, with the contribution of hydrodynamic lubrication being more important for the drawing of soft wires such as aluminum and for drawing with solid soap lubricant. The use of a pressurized die for wire drawing is suggested by Milliken (105) as a means of improving wire-drawing lubrication.

A review of commercial procedures and lubrication practice in the drawing of tubes and bars of ferrous and nonferrous materials is provided by Perry (106) who also lists the functions of tube-drawing lubricants and suggests that available evidence supports the view that the quasi-hydrodynamic state of lubrication is operative in commercial tube and bar drawing. A study of a plain mineral oil, an oil containing fat, and oils with mild and active EP additives has been made by McFarlane and Wilson (107). These authors found that the improved properties of the EP oils, as shown by tests in a slider rig, were not evidenced in drawbench trials, the oil containing fat proving somewhat superior to the oils with

EP additives for drawbench reductions greater than 40 per cent.

The so-called "anomalous" drawing properties of aluminum sheet were shown by Loxley and Freeman (108) to be controllable by lubrication procedure. Their experimental results confirm the theoretical conclusion that for stretch-forming, deep-drawing, and ironing operations, good lubrication should be maintained between the die and the outer surface of the work, with no lubricant applied to the punch or the inner surface of the cup. A laboratory test for the evaluation of lubricants, particularly for deep drawing, has been devised by Wojtowicz (109), using a strip-type die with an adjustable side pressure. His results show that lubricants are often specific for certain metals with respect to both low-friction and antiscoring behavior. These two desirable properties are not necessarily related.

Zirconium, like titanium, has a marked tendency to gall under sliding contact with other metals. Lubrication problems (110) in the hot-working of this metal are solved either by copper sheathing or by the use of glass as a lubricant while, for cold-forming processes, a lacquer-molybdenum disulphide mixture, or an oxide or phosphare coating in conjunction with conventional lubricants, are currently the best procedures. Molybdenum-base alloys (111) also may be extruded hot from ingots with glass lubrication (Ugine-Sejournet process). A proprietary phosphate coating (112), developed for steels from the German wartime use of phosphate coating for the deep-drawing of steel cartridge cases, has had considerable success in the cold-working of steels, and appropriate cleaning agents and lubricants for use with this coating method have been worked out.

An interesting account of the work of the Mechanical Engineering Research Laboratory near Glasgow, Scotland, administered by the British Department of Scientific and Industrial Research is given in *Machinery* (113). Both practical and fundamental problems, including metal cutting, metal forming, lubrication, and wear are studied here.

Metal Cutting. Several papers describing metal-cutting researches were included in the Institute of Petroleum symposium already mentioned (114). Stabler (115), who reviewed existing knowledge of the cutting process to indicate fields for future research, emphasized the importance of the chip-tool interface in the distribution of cutting forces. The effectiveness of chlorinated hydrocarbon cutting-oil additives was investigated by Wolfe (116) and his co-workers with respect to the type and concentration of these compounds by means of a careful drilling-test technique. The requirements of cutting oils and methods of mechanical testing are discussed by Morton and Tourret (117). They pay particular attention to a drilling test and give numerous results showing how such a test can differentiate between a variety of formulations. For SAE 1113 and 4135 steels, a study of the angle relationships of an orthogonal metal-cutting operation by Creveling and Thomsen (118) (HSS tool, 30 fpm) showed that these were not appreciably different whether cutting was done in air, with a soluble-oil emulsion, or with carbon tetrachloride as lubricant. Beiswanger, Copes, and Mayhew (119) recommend a tool weight-loss method for evaluating cutting fluids. They found total tool wear to be a linear function of the amount of metal removed under their test conditions.

The use of the specific work of abrasion (work of friction/weight loss of tool) as a relatively rapid means of studying and comparing the behavior of various cutting lubricants is described by F. Eugene (120, 121). Plots of specific abrasion against tool-workpiece interface temperatures permit the comparison of lubricants without appreciable dependence on the conditions of the cutting or the tool characteristics. An interesting conclusion of Eugene's work is that the cooling effect of the lubricant is relatively unimportant. Not only do aqueous lubricants have limited conditions of use, but also beyond these limits they result in greater abrasion than in dry cutting. Chisholm (122) also discusses the cooling and lubricating effects of cutting fluids and gives an account of methods for the evaluation of their lubricating and wear-reducing properties. Work on the effect of the cooling of cutting fluids to 2 to 4 C by Pahlitzsch (123) indicates that, for deep drilling with an oil emulsion, the drill life, amount of metal removed by regrinding of drills, power consumption, workpiece surface temperature, and chip form are all considerably improved by cooling the cutting fluid. Drill life was increased by a factor of $2^{1}/_{3}$ while costs were reduced by $^{1}/_{3}$. A second paper by the same author (124) shows that cutter life in the milling of gears is also increased 50 to 100 per cent by cooling the cutting fluid to about 5 C.

An investigation of the influence of grinding fluids on the residual stresses produced by grinding hardened steel is reported by Letner (125) who, using grinding conditions typical of commercial practice, found that maximum stresses from —140,000 psi (compressive) to +160,500 psi (tensile) could exist, the depth of the effect being up to 0.006 in. He concluded that the effectiveness of a grinding fluid in reducing undesirable residual stresses depends on its ability to lubricate rather than to carry away heat after it has been generated. Stresses obtained with water-base fluids differed little from those resulting from dry grinding, while the best fluid was a sulphochlorinated mineral oil with a high content of sulphochlorinated fats. Coes (126), who discusses the chemistry of the grinding process, points out how increasing knowledge of this subject can provide better understanding and more rapid progress in the development of both grinding wheels and grinding fluids. The effect of grinding-oil additives in abrasive-belt grinding is demonstrated by Dyer (127), who explains his results in terms of the wear of the abrasive grains.

By machining radioactive copper in a planing operation, Finnie and Rabinowicz (128) were able to study the tool-work contact through autoradiographs taken after each cut. They found that metal transfer and wear were similar to that experienced in a sliding experiment under comparable conditions.

A considerable volume of Russian work on cutting oils as well as metalworking oils is currently being published, notably by the school of Rehbinder. This work is briefly summarized by the paper of Epivanov and others (129). The effect of so-called surface-active agents (e.g., oleic acid) is here attributed to modifications of the surface structure of the metal by the catalytic decomposition products of the active agent.

Problems in the machining of titanium are frequently discussed in the literature (130, 131) and are commonly attributed to the high tool-tip temperatures attained. The use of sulphurized and chlorinated mineral-oil compositions is recommended here. Grindrod (132), in one of many papers on the use of carbon dioxide in machining, suggests that in special cases the increased cutting speed and tool life obtainable may make this new technique economically advantageous. If molybdenum disulphide, as a colloidal dispersion in a volatile solvent, is applied to the clean surface of cutting tools and baked on at 200–300 C., it is claimed by Gordon Kay (133) that great improvements in tool life may be obtained in various operations. Such films are also effective for press and drawing dies, and additions of colloidal molybdenum disulphide both to cutting oils and metalworking lubricants are said to improve their performance.

Rolling-Element Bearings

Nemeth and Anderson (134) studied 20-mm-bore tool-steel ball bearings, operating at 2500 rpm, when lubricated with graphite and/or molybdenum disulphide. Effective lubrication at 1000 F was obtained with graphite at 850 F with molybdenum disulphide, and at 700 F with synthetic diesters. Molybdenum disulphide-air mist as a lubricant for roller bearings also was investigated. The same authors (135) also tested several lubricants in 20-mm-bore tool-steel ball bearings, operating at 2500 rpm, to determine the effect of air and nitrogen atmospheres. All lubricants tested in both nitrogen and air atmospheres were effective to higher temperatures in nitrogen atmospheres. Comparison showed that solid lubricants were best in either air or nitrogen atmospheres.

Empirical methods were developed by Martin and Baker (136) to forecast the life of self-enclosed grease-lubricated ball bearings. They include the procedure for predicting, with some certainty, life of bearings whose limiting factor is grease. White, Swindells, and Belcher (137) ran endurance tests at 325 F and 10,000 rpm with oil-soaked felt pads which contact the outer race and bleed oil slowly to the bearings. These endurance tests were conducted with mineral oils, silicone fluids, and polypropylene-glycol derivatives.

Hanau and Hecht (138) have classified gas-turbine bearings into three general size groups. They discuss the theory of design of high-speed bearings, as well as the designing of the cages. Johnson and Bisson (139) show that materials currently used in rolling-contact bearings for turbine engines are limited by temperature to such an extent that completely new materials are under consideration. The friction and wear properties of several materials for bearings and their cages when subjected to high speeds and temperature are shown. An accounting of research work in the United States on anticorrosive properties of lubricants for tapered roller bearings in aircraft wheels is discussed by Thomson (140).

Gremer (141) discusses plastic antifriction-bearing cages and the running properties of plastic bearing cages under unfavorable operating conditions. He tested five different plastics. A comparison with brass and steel indicated more favorable behavior of plastics.

Villforth and Muenger (142) summarize the research on the lubrication of railroad roller and plain bearings, including notes on test machines. Graneek and Wunsch (143) discuss a machine which was developed to obtain information on the performance of high-precision bearings of small diameter which provides continuous measurement of frictional torque of bearings under defined axial and radial loading at speeds up to 50,000 rpm.

Gradwell and Kaye (144) worked on the computation of critical speeds of rotor systems using a Ferranti digital computer. They explain how the computer is used. This critical-speed program is general enough to treat any desired arrangements of bearings and disks, provided that the number of disks does not exceed 60.

Hampp (145) shows how to select antifriction bearings for gears, the selection depending upon the load, speed, and required life of the bearing. He points out the requirements of gear bearings, and gives a basis for the selection of bearings for spur, worm, and bevel gears, and motor-vehicle gears. Jania (146) discusses a simple, fast, and accurate graphical method of calculating both direction and magnitude of bearing loads resulting from gear action. The method uses the total force acting on the gear directly in place of separating the forces into components. Meldau (147) shows how pressure is distributed in groove-type radial ball bearings under pure moment load. Dempsey (148) gives examples of several types of ball-bearing damage, causes of the troubles, and the use of a noise test machine in determining particular ball-bearing failure.

Gears

Niemann (149) discusses the formation of a lubricating-oil film particularly on the gear-tooth flank. He shows loss and damage limits for involute gears and equations covering the lubrication theory for rolls. Further discussion by Lewicki and Cameron (150) of Cameron's measurement of the lubricant-film thickness between gear teeth (see the Digest for 1954) throws more light on the validity of Cameron's methods and results.

Recent changes in worm-gear ratings and their influence on lubrication are presented by Moir and Crane (151). Watson (152) illustrates how to determine and select a suitable gear lubricant and shows the importance of coefficient of friction as referred to gears. Critchlow (153) analyzes gears used in the steel industry, with some reference to lubricants, lubrication, and tooth failures.

Automotive Lubricants

Crankcase Lubricants. Fleming, et al. (154), predict that the use of volatile fuels with multigraded lubricants will permit increase of compression ratios up to 10:1. In a controlled road test, satisfactory operation at this compression ratio was achieved with 10W-30 oil and a 98–99 research octane fuel of 302 F 90 per cent point. With conventional lubricants and higher boiling fuel, it is estimated that octane rating in excess of 100 would be required. Vollentine (155) points out that oil-change periods can often be extended when Series 2 oils are used in diesel engines which normally operate on 2104B oils. Increases in engine life by factors of 2 or 3 also may be realized, depending on engine type, load, and fuel characteristics.

Data presented by Overcash, Hart, and McClure (156) indicate lower octane-requirement increase but somewhat higher oil-consumption rates for an SAE 10W-30 oil compared to SAE 20 in road tests. Georgi (157) points out that while use of multigraded oils may result in less octane-requirement increase under stop-start driving conditions, they require higher concentrations of antiwear additives than conventional oils. Gates, Bergstrom, and Wendt (158) report further field cases of used-oil analysis based on the "oil-spot" method.

Engine Wear. Brenneke and Estey (159) discuss a number of aspects of engine wear. Their data indicate that chrome-plated top rings wear at a lower rate than unplated top rings in the same engine, that Series 2 oils do not impede run-in in a given engine, and that high ring pressure which results in low oil consumption is frequently accompanied by higher wear rates. Nutt, Landen, and Edgar (160) ascribe high rates of ring and cylinder wear in diesel engines to higher surface temperatures than the lubricant can withstand. They suggest the use of lubricants of increased high-temperature viscosity, decreased volatility, and maximum thermal stability. A study of the abrasive wear of piston rings by Watson, Hanly, and Burchell (161) leads to the conclusion that particles less than 1 micron diam are not harmful in this respect. Ring wear is shown to be rather insensitive to engine speed and oil viscosity in the range SAE 10-50, but quite dependent on engine load.

Results of extensive bench testing of cam-tappet combinations are reported by Etchells, et al. (162). It is concluded that cam design should seek to minimize contact stress, rubbing velocity, and deflection of mating parts; good surface finish is desirable. Hardenable cast-iron tappets and camshafts are vastly superior to steel parts in scuffing resistance in this service. Oils differ in their ability to relieve distress of these parts, particularly if steel is the material of construction. A study of hydraulic valve-lifter complaints is reported by Parker and Savage (163), who found that many extraneous noises were blamed on valve lifters by car owners. Where lifters were actually noisy, dirt and internal lifter wear were the principal causes. They found no cases where lifters did not operate because of lacquer deposits in the clearance space between the plunger and lifter body.

Engine Deposits. According to Rogers, Rice, and Jonach (164), low-temperature sludge deposits in gasoline engines are formed primarily from partial oxidation products of the fuel. The success of additives in reducing these deposits is due chiefly to inhibition of the reaction by which oil-soluble contaminants are converted to insoluble deposits. A new type of detergent additive, a copolymer of lauryl methacrylate and diethylaminoethyl methacrylate, is described by Willis and Ballard (165). In bench tests, engine tests, and road tests this detergent has been found superior to the sulphonates and phenates tested in preventing formation and deposition of sludge and varnish, particularly under low-temperature conditions.

Grease. Road tests designed to evaluate chassis lubricants are described by Kehoe (166). It was found that the friction of the front-end suspension as measured did not increase significantly over 6000 to 7000 miles without lubrication, but handling qualities of the test vehicles depreciated long before that distance. McGrogan (167) evaluated four greases on twelve test cars of two different makes. Under 1000 miles of operation there was little effect on drivers' complaints due to grease type; however, the effects varied widely for the two chassis designs. With both designs, a substantial increase in number of complaints occurred beyond 1250 miles; consequently, 1000-mile lubrication frequency is recommended.

The advent of automatic chassis lubricators has prompted study of rheopectic lubricants. These feed readily under low pressure, but are irreversibly converted to grease when dispensed. Neesley, Brunstrum, and Liehe (168) found that such a product fed satisfactorily at —20 F yet did not drip from the chassis at 100 F.

Properties of Lubricants

Rheology. De Witt (169) has formulated an equation of state which predicts non-Newtonian behavior for fluids of appreciable relaxation time. Where shear rates or relaxation times are low, it reduces to the Newtonian case. A theoretical equation for viscosity-temperature relations of associated liquids is proposed by Girifalco (170). The author assumes two types of action, one involving dipole interactions and the other dispersion forces. Rheological behavior of many types of materials including Newtonian fluids and Bingham bodies is reviewed by Brancker (171).

Barber, Muenger, and Villforth (172) describe a novel rotational viscometer capable of measurements at shear rates in excess of one-million reciprocal seconds. These rates are achieved by precise machining to very close clearances and by temperature control of the rotating and stationary elements.

Groff (173) proposes a modified viscosity index, which is the ratio of the actual VI to that of a lubricant which has the same viscosity at 100 and 210 F and the same 210 F viscosity as the unknown oil. Vogelpohl (174) presents a discussion of the viscosity-temperature behavior of lubricants, with methods of estimating temperature rise and load-carrying capacity of journal bearings.

Dreher, Carter, and Reid (175) have been able to predict the apparent viscosity at —65 F of lithium-calcium greases (MIL-G-10924) from more easily obtained measurements. They find that the apparent viscosity of grease made with this soap mixture is a linear function of oil viscosity, soap content, and worked penetration. Connor (176) describes an automatic worker-viscometer for grease. The sample is forced back and forth through a tube; the pressure drop at any time is a function of viscosity.

Foreman (177) has measured viscosities at 0 F of polymer-blended solvent-refined oils using a rotational viscometer at a maximum shear rate of 60 $\sec^{-1}$. He found that polymethacrylate blends generally had measured viscosities at 0 F higher than the values obtained by extrapolating the 210 and 100 F viscosities. Bright stock appears not to produce this effect. Klaus and Fenske (178) studied methacrylate, butene, and styrene-polymer solutions in oil. They found that all oils containing these polymers underwent viscosity loss at high rates of shear, but that viscosity was completely recovered as long as the flow during shear was laminar. When the flow was turbulent, permanent viscosity loss was found. Temporary and permanent viscosity losses are proportional to the molecular weight and concentration for a given polymer type.

Viscosity measurements on two silicones and several silicate esters at pressures up to 2000 kg/sq cm are reported by Kuss and Schultze (179). Other experiments at higher pressure are described which illustrate structural changes occurring in the surface layers of metals in contact with oil when pressure is suddenly released. Sargent (180) reviews published data on the effect of pressure on the viscosity of fluid lubricants, pointing out the need for accurate data at elevated pressures. Examples show how calculations for flow, pressure drop, film thickness, etc., can be in error at high pressures unless effect of pressure on viscosity is taken into account.

A correlation of published pressure-viscosity data is given by Hartung (181). Using the author's charts, viscosity of lubricants at 100 and 210 F can be predicted from atmospheric pressure densities and viscosities.

Analysis. Analysis of used crankcase oils for copper by an emission-spectrograph technique is proposed by Hodgkins and Hansen (182). Their method is quite rapid and appears to be sufficiently accurate for routine determinations. Gunn (183) describes the use of the emission spectrograph in routine analyses of lubricating oils for calcium, barium, and phosphorus. The emission spectrograph has been used by Key and Hoggan (184) to analyze greases for aluminum, calcium, lithium, sodium, and barium. Their method involves solution of the grease in a mixture of solvents and use of a rotating-dish electrode. Gent, Miller, and Pomatti (185) describe a new method for the spectrographic determination of relatively large amounts of metals and phosphorus in oils and greases. A graphite-copper-oxide mixture is heated with the sample to burn off the oil, after which the residue is arced.

Melpolder, et al. (186) used a mass spectrometer to study lubricating-oil fractions produced by batch thermal diffusion treatment of a pipe-still distillate. They found 16 different hydrocarbon species in this moderately narrow cut.

Putscher and Fred (187) have used the refractivity intercept (refractive index—0.5 density) to identify Pennsylvania oils. The unknown oil is silica gel percolated, and measurements on the paraffin-naphthene fraction are shown to be quite specific for oils of Pennsylvania and non-Pennsylvania origin. Irish and Karbum (188) found that major classes of components of lubricating oils can be separated in an adsorbent column to give reproducible chromatograms. However, these are likely to be inaccurate pictures of the spread of properties of the components of the oil unless a very small column load is used.

Synthetics. Davidson, Cooley, and May (189) review Air Force experience with synthetic gas-turbine lubricants. Particular problems have arisen with coking in hot spots, film strength, and compatibility with certain materials of construction such as insulation, seals, and gaskets. In general, bulk thermal stability, oil-consumption rates, resistance to foaming, and corrosivity are satisfactory. Air Force experience with high-temperature greases is summarized by Schwenker, King, and Mosteller (190). Arylurea-silicone greases are under continuing development for the range —65 to 450 F. Other thickeners being studied include Bentone 34 for the range up to 700 F, and lithium 9/10 hydroxystearate as a replacement for lithium 12 hydroxystearate, which is derived from an imported material.

Incorporation of halogen-bearing phenyl groups into the silicon chain of silicone oils is shown by Gainer (191) to improve the lubricating properties of these oils for steel against steel. Wear rates and coefficients of friction were reduced, with some sacrifice in viscosity-temperature coefficient. Reynaud (192) describes the preparation of polymerized diesters of maleic and fumaric acid, with data on viscosity, viscosity index, thermal stability, and low-temperature characteristics.

Physical, electrical, and lubricating properties of a number of fluorocarbons and chlorofluorocarbons are presented in a comprehensive article by Rudge (193). Comparisons are drawn with other synthetics regarding flammability, oxidation stability, and so on. Henderson, Murphy, and Ravner (194) report physical and chemical properties of esters made by reacting fluorinated acids or alcohols with unfluorinated alcohols or acids. Some of the fluorinated-alcohol compounds show great promise for high-temperature applications because of their good thermal and oxidation stability.

Laboratory flammability, corrosion, and thermal-stability tests for synthetic fluids are described by Watson (195). Results of tests on a number of types of synthetic lubricant are included. Harris (196) reviews the requirements of synthetic hydraulic fluids, with particular regard to flammability, lubrication, viscosity, stability, and compressibility. O'Connor (197) summarizes progress and problems in the application of fire-resistant fluids for turbine lubrication.

Greases. Hutton, Matthews, and Scarlett (198) studied the structure of greases under the light microscope. Their results indicate that the soap is generally present as elongated fibrils which aggregate into fibers. Study of individual fibrils requires the electron microscope, but the light microscope is very useful for work with the aggregated fibers. They conclude that the texture of a grease is determined by the degree of aggregation, a fibrous grease resulting from the formation of distinct fibers, while a grainy grease is made when the fibrils form looser clusters.

In experiments reported by Renshaw (199) it was found that the Navy "grease worker" softened lithium greases and oriented the fibers, but had little effect on length/diameter ratio. For the same greases in a high-speed ball-bearing test, consistency was affected less, but the fibers were broken up to a high degree. Consequently, loss of consistency does not appear to depend on length/diameter ratio alone.

Properties of inorganic gelling agents for greases are reviewed by Peterson and Bondi (200). Principles relating finished grease properties to the structure and surface of the gelling particles are pointed out. McClellan and Calish (201) report field and laboratory data on incompatibility of greases made with different soaps.

Miscellaneous. Farrington (202) reviews a number of advances in the fields of physical and chemical properties of hydrocarbons, lubricating oils, lubricating greases, and friction and wear. A bibliography of 33 references is included, principally from the years 1952 and 1953.

Foaming tests carried out by Pugh and Tichvinsky (203) indicate that the result of a laboratory test of foam rate of a heavy-duty motor oil is influenced by its past history. Air rate and temperature must be controlled carefully, and only calibrated porous plugs should be used in testing.

Bonauguri, et al. (204) have correlated the oxidation behavior of petroleum lubricants with type composition and mean molecular weight. A theory accounting for the oxidation characteristics of lubricants is proposed by Rumpf and Jahn (205).

Density-temperature-pressure relations for liquid lubricants are correlated by Hartung (206). The relations proposed are suitable for use to 80,000 psi and 425 F.

Books. A concise volume by R. R. Slaymaker (207) treats journal-bearing lubrication with regard to load-carrying capacity, oil flow, temperature rise, and friction. Methods of computation are extended to cover bearing design. Other topics covered briefly include properties of lubricants, bearing construction, oil-less bearings and boundary conditions in bearings. This is a very practical book, carrying basic theory over into usable expressions that have been proved reliable.

An OTS Research Report on Synthetic Lubricants (208) contains a survey of more than 800 compounds, most of them esters, considered for this service. Many of these materials were evaluated for properties which would make them useful as lubricants, particularly for aircraft applications.

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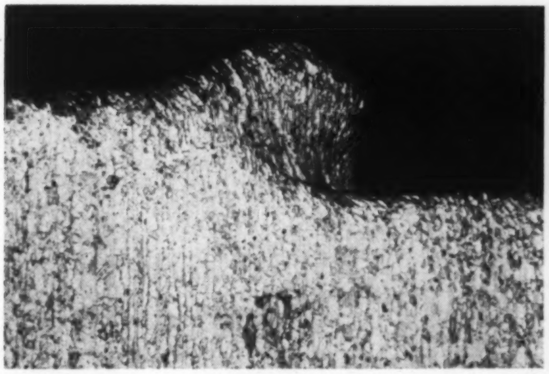

Fig. 1 Photomicrograph of partially formed discontinuous chip. Material, β brass; rake angle, 15 deg; depth of cut, 0.008 in.; cutting speed, 0.5 ipm; no cutting fluid.

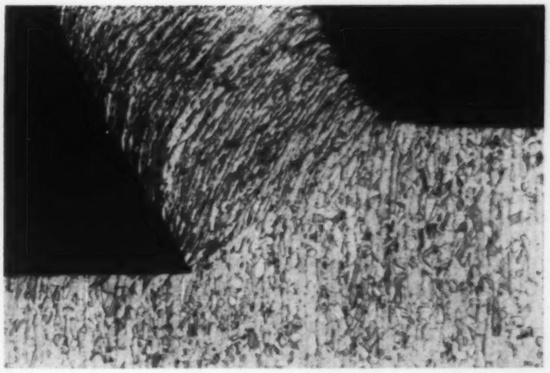

Fig. 2 Photomicrograph of continuous chip. Rake angle, 30 deg; depth of cut 0.010 in.; other conditions as given in Fig. 1.

Review of the Metal-Cutting Analyses of the Past Hundred Years

Early studies supply basis for modern research in field of metal cutting—Basic relationships between many variables still lacking of solution

By I. Finnie[1]

Instructor, Mechanical Engineering Department,
Massachusetts Institute of Technology, Cambridge, Mass.

ATTEMPTS to measure and understand the variables in metal cutting accompanied the beginning of an active commercial interest in this process. A number of machine tools were developed in their present form between 1840 and 1850 and at about the same time the first scientific papers on metal cutting appeared. The early analytical studies kept pace with practical developments until about 1900. By this time the analysis of cutting forces had become almost as well developed as it is today. However, at the turn of the century, the tremendous step forward in the practical art of cutting, which resulted from the discovery of high-speed steel by Taylor and White in 1898, left the analytical side behind. A large number of practical tests of an empirical nature were made in the years after 1900 and these seem to have overshadowed some of the early analytical work. Recent investigators, in trying to develop analyses of cutting, in many cases have started afresh without the benefit of the early works.

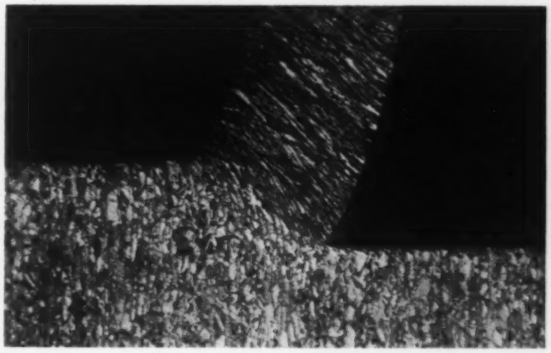

Fig. 3 Photomicrograph of continuous chip with built-up edge. Rake angle, 15 deg; depth of cut, 0.007 in.; other conditions as in Fig. 1.

Despite the large number of attempts, past and present, to analyze metal cutting, a basic relationhip between the various variables is still lacking. This is all the more tantalizing when compared with the success which has been obtained in predicting the behavior of other metal-forming operations. The cutting process is consequently a challenging field of research and is currently attracting the attention of workers in metal plasticity, as well as those concerned with the more immediate applications to practice.

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[1] Now Engineer, Shell Development Company, Emeryville, Calif.

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It was thought that a review of some of the early analytical work would be of interest and of some value to present-day workers in this field. A number of historical references were given by Ernst (1)[2] in an article on metal cutting. This was of considerable assistance in tracing some of the early papers and the author's debt to Mr. Ernst should be acknowledged. Books on metal cutting by Isnardi (2) and Panchenko (3) have appeared recently in the foreign literature. These contain a number of historical references and also have been of assistance.

Before discussing the early work, it may be helpful to give a brief description of the cutting process as it is now studied.

Present Picture of Metal Cutting

In most metal-cutting operations, the processes involved are three-dimensional. Many investigators have simplified the analysis by considering the two-dimensional case in which a tool whose edge is perpendicular to the cutting direction is moved parallel with the surface of the metal being cut. If the further restriction is made that the depth of cut is small compared to the width, then there will be little side flow of metal, and the process is one of "plane strain." The problems in extending this analysis to the three-dimensional case should be mainly geometrical.

In examining the cutting process several different types of chip formation may be observed. The classification usually adopted is due to Ernst (4) who listed: Type 1 discontinuous chip; Type 2 continuous chip; Type 3 continuous chip with built-up edge. No sharp division exists between these types. Figs. 1, 2, and 3 illustrate their occurrence in the same material under slightly varying conditions. The material may flow off in a continuous ribbon, purely plastic deformation taking place, or may fracture to a varying degree. With either of these conditions cutting may take place with part of the material being cut adhering to the nose of the tool in what is known as a built-up edge.

A completely different type of cutting is observed on some occasions when cutting cast iron or other very brittle materials. A crack propagates downward from the tip of the tool and material is removed by what appears to be a tearing process of tensile rupture. This can be seen in some of the photographs of Okoshi (5) and Schwerd (6).

Examination of the photomicrographs, Figs. 1, 2, and 3, reveals two major processes:

1 A highly localized shear strain extending from the tool point to the work surface. This shear strain may cause only plastic deformation or may result in partial or complete shear fracture.

2 Friction along the tool-chip interface. This process is extreme enough in some cases to cause adhesion of the chip to the tool.

For the case of continuous cutting, the shear process is described by the angle (shear angle) which the zone of intense strain makes with the cutting direction. The friction process is characterized by a coefficient of friction. That the two processes are not independent of one another may be seen by the change in shear angle produced by different cutting fluids. The conventional idealized picture of continuous cutting used in most present-day analyses is shown in Fig. 4. Measurements are usually made of the chip length and the force components and sometimes of the contact length between the chip and the tool. From these measurements the shear angle, shear strain, friction coefficient, and stresses may be calculated. The fundamental problem facing investigators is that of obtaining a relation between the shear angle, the coefficient of friction, the rake angle, and other variables for continuous cutting. In addition, one would like to predict the occurrence of fracture in the shear process and adhesion or built-up edge in the friction process.

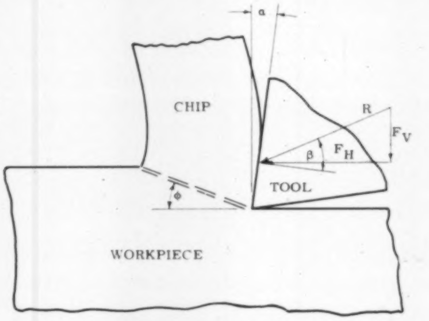

Fig. 4 Conventional idealized picture of continuous cutting used in present-day analyses

Historical Survey

The earliest reference which could be found relating to scientific studies of the cutting process is due to Cocquilhat (7) in 1851. He cut with a drill which was held fixed while the workpiece rotated. The drill was advanced at a constant speed, the torque being measured by weight balance. The work required per unit volume of material removed and the force per unit area of cut were tabulated for cast iron, malleable iron, brass, stone, and other materials. With the knowledge of the work required per unit volume of material removed and assumptions of wages and working days, he then made some interesting calculations on the costs of digging tunnels, cutting marble, and trench digging. This work was extended by Clarinval (8) who studied the influence of cutting fluids and gave a formula for the work required to turn a drill as a function of its diameter.

In 1858 Wiebe (9)[3] published the formula

$$P = KEB \ldots\ldots\ldots\ldots [1]$$

where P is the work required to remove a piece of material of width B and thickness E, and K is a constant for a given material. Although this now seems rather elementary, it represents, with the work of Cocquilhat, the first attempts to analyze the process. Further tabulations of the work required in machining were given in a book by Hartig (10) in 1873. This seems to have been the authoritative work in its field for many years.

The first experiments in which the influence of tool geometry was studied were reported by Joessel (11) in

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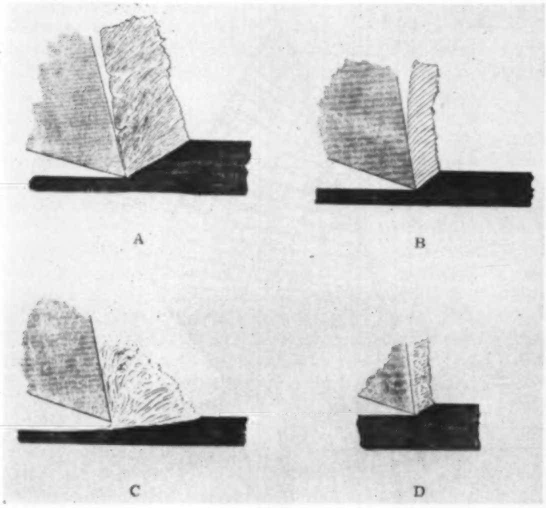
[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

[3] The original of this reference was not available for study. The information is taken from reference (3).

1864. Forces were obtained in lathe cutting and drilling by measuring the torque required to turn the machine while cutting, care being taken to subtract the torque required to overcome the friction of the machine. The effects of depth of cut, speed, and rake angle were studied, and it was concluded that the least force in the cutting of iron was obtained with a 35-deg rake angle in lathe cutting and a 70-deg angle in drilling. References to cutting fluids also may be found at this time. Linseed oil, camphor in water, quicklime solutions, and nitric acid were mentioned.



A, Shaving of wrought iron (armor plate). Actual thickness 0.25 in.
B, Shaving of brass. Actual thickness 0.08 in.
C, Shaving of copper (unlubricated)
D, Shaving of copper (lubricated with soap and water)

Fig. 5 Drawings made by Mallock from polished and etched chips

Chip Formation. The first attempts to explain chip formation are those of Time (12) in 1870 and Tresca (13) in 1873. In a paper on the planing of metals and later in a general study on the flow of solids (14), Tresca described very completely the appearance of the chips produced in different operations. This famous French scientist, who was a pioneer in the study of the plastic flow of metals, went astray in describing the mechanism of cutting. Tresca implied that the cutting process was one of compression ahead of the tool, which accounted for the chip length being shorter than the workpiece, combined with a shearing on a plane parallel to the surface of the work which separated the chip from the work.

In 1877 Time published again (15) the paper comparing his own earlier work with Tresca's. He discussed Tresca's paper at length and pointed out that material is not being compressed ahead of the cutting tool but has been sheared. This was substantiated by experiments on many materials. He also discussed brittle materials, pointing out that, in these, shear is not involved, the chip being removed by fracture. Time also obtained the correct expression for the ratio of chip length to workpiece length (chip-length ratio) in terms of the geometry of the process and justified it experimentally. The major criticism that can be made of his work is that he seems to have considered chip formation as taking place by fracturing of the metal on successive shear planes rather than by plastic deformation. However, the plastic deformation of metals in operations other than cutting was only beginning to be investigated by Tresca and others at that time.

Other investigations on chip formation were made by Mallock (16) in 1881. His drawings of polished and etched chips, shown in Fig. 5, are almost as clear as modern photomicrographs. Mallock deduced correctly that the cutting process was one of shear along a sharply defined shear plane with friction occurring along the tool face. However, as Time, he thought of fracture as occurring on the successive shear planes and described the chip as a "metallic slate." Mallock observed that the friction between the chip and tool was decreased when a cutting fluid, soap and water, was applied. His drawings also showed that when cutting copper the use of this fluid increased the shear angle. Further comments are made in this paper on the facts that tool bluntness will modify the analysis, and that tool vibration is due to the negative slope of the force-velocity curve in metallic sliding.

Measuring Cutting Force. Experimental methods for measuring the cutting force were slowly improving. Smith (17), in 1882, wrote a book "Cutting Tools" in which he described measuring the cutting force at speeds up to 10 fpm using a dead-weight balance. He said that Hartig's book (10) was still the only reliable source of information as to the power required by various machine tools. Smith rather took Hartig to task for the statement that cutting force is proportional to depth of cut. However, within the accuracy of Smith's own experiments, Hartig's conclusion seems justified.

In 1892 Haussner (18) built a planing dynamometer in which the work was restrained by a stiff spring. Deflections of the spring were magnified and a record was drawn by the dynamometer of force against distance of the cut. Although, as all previous investigators had done, he was only measuring the cutting force in the direction of tool velocity; i.e., F_H in Fig. 4. Haussner recognized that forces existed in other directions and showed what error this would introduce to his observations. He observed that "with ductile materials, after cutting started, chips welded to the tool and were very hard to separate. Sometimes this material flows downwards and increases the resistance to a high degree, the work piece looking smeared." This appears to be the earliest reference to a built-up edge being formed. Another observation was that "the shear force contains not only the pure shear resistance but another component which is needed to overcome a kind of secondary resistance which exists because the element is not freely sheared but is under a normal pressure." He includes this other component in his analysis. This is the first reference that could be found to normal stress influencing the shear process in cutting.

Planing. Zvorykin (19) published in 1893 the results of extensive theoretical and experimental work on planing. In his dynamometer, the cutting force was balanced by hydraulic pressure. This was recorded on an engine indicator which was driven by the planing machine and hence gave a diagram of force versus distance cut. Like Haussner, Zvorykin realized that the resultant force was not necessarily in the cutting direction. Assuming that the force in the direction of the cutting velocity would be a minimum, he obtained the following expression to predict the shear angle

$$\phi = 45 + \alpha/2 - \beta/2 - \beta'/2 \quad \ldots\ldots\ldots [2]$$

α and β are the rake angle and friction angle as shown in Fig. 4 and β' is a friction angle for the shear plane. It is not clear whether Zvorykin realized that plastic deformation rather than fracture was involved, but this does not affect the analysis. In this reference it is mentioned that Equation [2] with $\beta' = 0$

$$\phi = 45 + \alpha/2 - \beta/2 \quad \ldots\ldots\ldots\ldots [3]$$

has been proposed for shear-angle prediction at an earlier date. Equation [3] was derived again in 1896 in the German engineering handbook, "Ingenieur und Maschinenmechanik" (20). This time the basis of the derivation was that the shear plane would be the plane of maximum shear stress. Equations [2] and [3] have reappeared several times in the literature. Linder (21) in 1907, and Ernst and Merchant (22) in 1941, obtained Equation [2] while Piispanen (23) in 1937, and Merchant (24) in 1945, obtained Equation [3].

In the German handbook (20) the shear angles measured by Time were compared with Equation [3] and reasons for the disagreement were discussed. The fact that tool dullness would modify the analysis was noted, and a qualitative method of allowing for this by decreasing the effective rake angle was given. We may step ahead of our history by noting that in recent years a number of equations have been proposed for shear-angle prediction similar in general form to Equations [2] and [3]. None of these is completely in agreement with data and current opinion, as represented by the paper of Creveling, Jordan, and Thomsen (25) in that no such simple equation is sufficient to predict the shear angle.

Cutting Measurements by Dynamometer. Two papers of interest appeared in 1896. Sellergren (26) made cutting measurements with a dynamometer in which the tool was restrained by a spring. His picture of the cutting process was that the chip arose by the continuous displacement of small lamellae, either continuous as in soft steel, or discontinuous as in brittle materials. The force which overcame the resistance to shear appeared then as a normal force on the tool face which consequently caused friction at the tool face. Although his physical ideas of the process were very sound, his analysis of forces was not correct. This was true of many of the early experimenters who only measured one force, their knowledge of the direction of the resultant force being by hypothesis. Briks (27) also published a paper on the subject in 1896. The original could not be located, but he is given credit in some references (3, 28) for being the first to realize that plastic deformation was involved in metal cutting, and also for systematizing and clarifying the metal-cutting nomenclature. According to Ernst (1) the analysis of cutting given by Briks was very similar to that of reference (20).

A Misconception. There was a backward step in metal-cutting analyses in 1900 when Reuleaux (29), the famous German engineer, reported that he had seen a crack ahead of the tool and concluded that the cutting process was similar to the splitting of wood. This was confirmed by observations made by Kingsbury (30), who claimed that a crack ran ahead of the tool. Cutting fluids were apparently reaching the point of the tool, and it was felt that this would be impossible without a crack. The "crack" idea was immediately refuted by Kick (31) in a paper a year after Reuleaux's. He pointed out that what Reuleaux had seen was probably an optical illusion and drew attention to the work of Time. Experiments were made by Kick to show that there was no crack ahead of the tool. Nevertheless, the idea that metal cutting was analogous to splitting wood took a long time to die out.

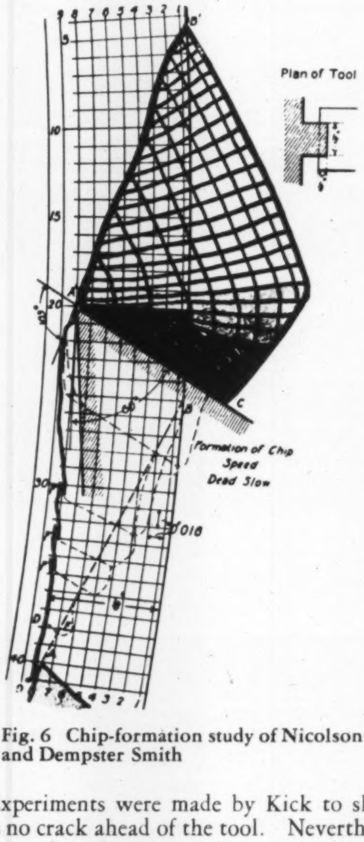


Fig. 6 Chip-formation study of Nicolson and Dempster Smith

In 1905 Brooks (32) showed photographs taken after stopping the tool while cutting different materials. They were among the earliest published photographs of cutting, previous workers having been limited by the printing techniques of their day. These photographs, together with the observations of Rosenhain (33) on polished and etched chips, helped dispel the theory that a crack preceded the tool. In Rosenhain's paper, plastic deformation is mentioned in connection with chip formation.

Lathe-Tool Dynamometer. Force measurement was becoming more accurate, and in 1904 Nicolson (34) reported on a lathe-tool dynamometer with which he measured the three components of the cutting force. Nicolson appears to have been among the first to use hydraulic pressure to measure cutting forces. It is recorded that in 1894 he built a dynamometer consisting of a diaphragm pressure gage in the tool box of a planer and presented it to Cambridge University. Nicolson and Dempster Smith (35) made some interesting experiments and observations on chip formation in a series of articles on "Machine Tool Design" in 1905. Fig. 6

is reproduced here from their section, "Formation of Chip," and shows their use of grids to study the chip formation.

The slow-speed chip which the authors wished to observe at their leisure was cut at what must be the slowest speed on record, 1 ft in $4^1/_2$ hr. Summarizing their observations, the fracture angle with the low-speed chip does not change with rake angle. At low speeds, slipping between the chip and tool is intermittent with longer intervals as the cut continues. The small cracks which form are healed by the large compressive stress. As the cut proceeds they become longer and less frequent, coinciding with the slip of the chip on the tool. Finally, one crack propagates to the surface and a new chip is started. At higher speeds there is less sticking of chip and tool, the compressive stress on the shear plane is less, and cracks are not readily healed up. However, because of the high speed of cut and finite speed of crack propagation, the chip moves out of the stressed zone before fracture goes all the way and is therefore not completely discontinuous. At these speeds a built-up edge was noticed which protected the cutting edge. The cratering of cutting tools was explained on this basis.

Tool Temperature. The years from 1905 to 1925 saw very little in the way of theoretical analyses of the cutting process. The first World War may have been partly responsible for this gap, but in addition, there was a growing interest in the more practical tests of an empirical nature. The classic work of Taylor (36) collected in his book "On the Art of Cutting Metals" (1907) gave impetus to this type of test. Taylor's work emphasized the role of tool temperature in determining tool life and, since then, there have been many articles on the measurement and prediction of tool temperatures.

In 1911 Brackenbury and Meyer (37) made calorimetric measurements of chip temperature while Usachev (38) in 1915, and later Schwartz and Flagle (39) measured tool temperatures with thermocouples inserted close to the cutting edge. However, it was not until 1925, when three independent workers (40, 41, 42) published the results of using the tool and the workpiece as the elements of a thermocouple, that tool-tip temperature measurements became possible. Subsequent workers also have used radiation studies (43) and temperature-sensitive paints (44, 45) to study the temperature distribution in the tool. Again, we run ahead of our history, but it is of interest to note that analytical studies of tool temperature are of fairly recent origin. The basic analysis was given first by Trigger and Chao (46) in 1951 and has since been modified and extended by other investigators. A discussion of experimental and analytical work on tool temperatures has been given by Loewen (47).

Photoelastic Experiments. Coker and Chakko (48) in 1922, and Coker (49) in 1925, carried out photoelastic experiments on the action of cutting tools. The stresses of interest, these along the shear plane and in the plastically deformed zone, are unfortunately not given by photoelasticity. It was shown from photographs such as Fig. 7, that there were zones of approximately radial compression and tension ahead of and behind a line going forward from the tool point. It also was shown that cutting without a cutting fluid gave a depressed shear zone (ahead of and below the normal shear zone) compared to the case with a good cutting fluid. This has been seen to occur also in the cutting of soft metals such as aluminum (50).

Chip Categories. Different types of chip formation were classified by Rosenhain and Sturney (51) in 1925. Their categories of "tear chip," "flow chip," and "shear chip" correspond, approximately, to the previously given categories of "discontinuous chip," "continuous chip," and "continuous chip with built-up edge." They showed that all three types of chip could be obtained in the same material by varying the cutting conditions. An interesting part of the paper is the excellent photomicrographs of the various types of chip formation. In one of their experiments a chip, originally with a built-up edge, when annealed showed a continuous grain structure. This proved that in some cases the built-up edge was integral with the chip and not an accumulation of scraped-off particles as hitherto had been supposed.

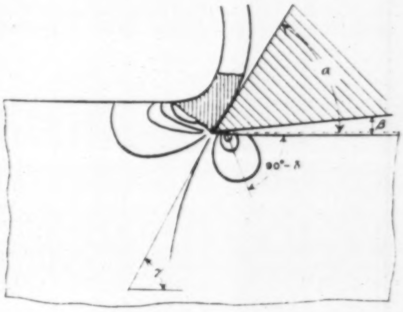


Fig. 7 Photoelastic test of Coker. Curved lines are actually colored in photograph and represent trajectories of constant shear stress. Nomenclature differs from Fig. 4.

By this time there had been several investigations of cutting forces for different speeds, feeds, rake angles, and so on. At the same meeting at which Rosenhain and Sturney presented their paper, a paper was given by Stanton and Hyde (52), "An Experimental Study of the Forces Exerted on the Surface of a Cutting Tool." Their force measurement appeared to be the most accurate up to that time.

Hardness Studies. Hardness studies were made on partially formed chips by Herbert (53) in 1926. By showing that the chip material was harder than the parent material, he demonstrated that metal cutting involved intense strain hardening which could only have come about by plastic flow.

The next stage in studying the cutting process was to take photographs while cutting instead of stopping the tool. This was done by Ishii (54) in 1929 and later by Schwerd (6, 55) whose excellent photographs have been used many times by later investigators. Photographs taken through a microscope and visual observations were recorded by Boston (56) who comprehensively described the appearance of the metal-cutting process.

Research in Japan. The work of Ishii (54) and Okoshi (5) marked the beginning of metal-cutting research in Japan and was followed by three interesting papers (57, 58, 59). Okoshi and his collaborators observed the transition from one type of chip to another, taking many photographs. They tried to find the direction of metal flow and the stresses involved by scribing gratings on the pieces being cut and by photoelastic experiments. Their force measurements were made with piezoelectric pickups, and the frequency response of their instruments apparently exceeded that of any previous dynamometer.

General investigations of chip formation, similar to those of Rosenhain and Sturney were made by Wallichs and Opitz (60, 61) and Wallichs (62) between 1931 and 1933. From that time the growing knowledge of the processes involved in cutting led to publications becoming more specialized. After about 1930, papers appeared on the separate aspects of built-up edge formation, discontinuous cutting, and continuous chip formation, and it will be logical to continue this review under these headings.

Built-Up-Edge Formation

It was mentioned previously that built-up-edge formation had been discussed by Haussner (18) in 1892 and by Nicolson and Dempster Smith (35) in 1905, while Rosenhain and Sturney (51) were the first to show that in some cases the built-up edge was actually part of the chip. Schwerd (63) in 1931 claimed that the existence of the built-up edge depended only on velocity. He showed that for a certain steel above 75 meters per min there was no built-up edge, and a good work finish was obtained. Okoshi (58) also credited the velocity with the major role in the existence of a built-up edge, claiming that the decreased friction at high velocities had the same effect as adding a lubricant. Rapatz (64), however, in a detailed study of built-up edge and resulting surface finish, concluded that temperature of cutting was the significant variable and velocity only important in that it modified the temperature. This conclusion was supported by experiments in which the built-up edge produced at low speeds was eliminated by preheating the workpiece.

Ernst and Martellotti (65) re-emphasized that the built-up edge is not a collection of particles gathered by the tool as it passes over the work but is part of the chip which develops in a shape similar to a cutting tool owing to the distribution of stress in the cutting process. They mentioned that the built-up edge is continually being built up and broken off. Parts of it are carried off periodically by the chip and by the work surface with consequent poor surface finish. In some cases before built-up-edge formation is completed, discontinuous cutting occurs and the built-up edge passes off with the chip segment. This illustrates the lack of a sharp deviation between the three types of chip formation mentioned previously. Carro-Cao (66) in a recent paper presents an interesting diagram for the breaking up of a built-up-edge once it is formed. It is imagined as an extrusion problem built up by combining two solutions from the theory of perfectly plastic solids.

Discontinuous Chip Formation

The first attempt to explain the formation of a discontinuous chip in terms of the mechanics of the cutting process and the properties of the material being cut is credited to Piispanen (67) in 1948. He concluded that the shear angle decreased during the chip formation with the shear strain consequently increasing and finally reaching a limiting or fracture shear strain. Field and Merchant (68) extended this analysis a year later by assuming that the decreasing shear angle was due to an increasing coefficient of friction on the tool face. Cook, Finnie, and Shaw (69) claimed that completely discontinuous chip formation was quite different from that of continuous chip formation and was one of periodic extrusion rather than simple shear. They pointed out that the coefficient of friction was static rather than dynamic in nature and showed that the important variable in determining when a continuous chip would become discontinuous was the normal stress on the shear plane. The most recent work is that of Lee (70) who has studied theoretically the early stages of discontinuous chip formation in a perfectly plastic solid (i.e., one which does not strain-harden).

Continuous Chip Formation

This type of chip formation is by its continuous nature more amenable to analysis than the previous two types. Many attempts have been made to analyze continuous chip formation and predict the shear angle by expressions such as Equations [2] and [3]. As the various theories have been discussed and criticized in recent papers by Shaw, Cook, and Finnie (71) and by Creveling, Jordan, and Thomsen (25), we will not review them here.

Recent Work of Great Value

The earlier papers have received greater attention in this presentation than those published in more recent years. The latter are generally known and more readily available. Many fine papers also have appeared on other aspects of metal cutting, such as tool wear, lubrication, and surface finish. These fall outside the province of this paper and have not been reviewed.

In many cases the same type of investigation has been made by independent workers in different locations. It is perhaps unfortunate that the assigning of dates to the respective publications tends to overemphasize the importance of the earliest papers. For example, while the work of Zvorykin and others, leading to Equations [2] and [3] for prediction of the shear angle in cutting, had relatively little influence on subsequent development, the very similar analytical work of Merchant, Ernst, and others almost 50 years later has been the basis of most of the present metal-cutting analyses.

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High-Pressure Pneumatic Conveying in the Lumber Industry . . .

. . . car loading chips by compaction and moving hogged fuel up to 5000 ft now being practiced

By I. A. Rader

President, Rader Pneumatics, Inc., Portland, Ore.

What is meant by high-pressure pneumatic conveying? In the lumber industry, certainly in the Northwestern States, with very few exceptions, the only pneumatic systems used prior to the past 3 or 4 years were blower-fan systems operating at pressures in the range of about $^{1}/_{8}$ to $^{1}/_{2}$ psi inch. The so-called "low-pressure" installations were generally exhaust systems, and were used to pick up sawdust, planer shavings, and similar lighter materials. For the first time 3 or 4 years ago high-pressure systems were presented aggressively to the lumber industry. Although generally operating in the fairly low pressure range of from 3 to 8 psi, nevertheless they were high-pressure systems in relation to the air systems generally in use at that time. Hence the term "high-pressure pneumatic conveying" was generally used to describe these newer systems in the lumber industry.

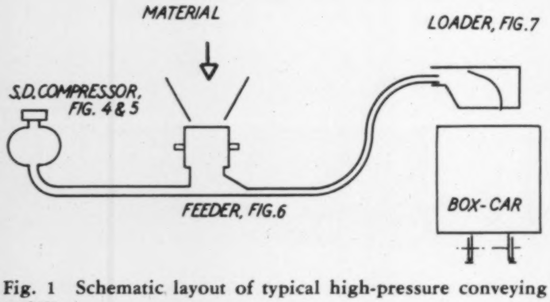

Fig. 1 Schematic layout of typical high-pressure conveying system

Fig. 1 shows a schematic layout of a typical high-pressure conveying system.

Comparison of High and Low-Pressure Systems

The basic difference between low-pressure and high-pressure systems is that a low-pressure system uses a centrifugal or axial-flow blower to provide the required air stream, while a high-pressure system utilizes a positive-displacement compressor. The basic difference is that the axial-flow fan or blower in low-pressure systems will deliver a certain quantity of air against a definite static or line pressure. If the static pressure is increased, the air output of the fan will drop. A positive-displacement compressor, on the other hand, operating at a constant speed, will theoretically deliver a fixed volume of air, regardless of the back pressure. This difference is probably best illustrated by two typical curves as shown in Figs. 2 and 3.

Positive-Displacement Compressor

Positive-displacement compressors have been in general use for many years. The operating principle of this type of compressor is shown in Fig. 4. In this illustration the right-hand rotor or impeller is being driven in a counterclockwise direction, and is generally geared to the left-hand impeller as shown in Fig. 5. With this direction of rotation the air is discharged at the top; if the rotation is reversed, the discharge would be at the bottom. The figure "8" impellers do not touch each other or the case during rotation. They are separated by minute clearances which are designed into the unit.

Theory of Pneumatic Conveyers

It is not the purpose of this paper to consider the methods or formulas used to arrive at pressure losses for a free-running air stream in a pipe. Pneumatic conveying is by no means an exact science, and our basic formulas for these losses were developed quite generally in accord with those used by W. G. Hudson.[1] Some adjustments in constants were made on the basis of our results in actual installations.

The question of determining material losses, however, presented many more problems. In this case we started by using basic formulas as outlined by Hudson, but these were adjusted quite substantially as the result of field installations.

The next problem was to determine the necessary air velocity, as well as the volume of air required. The velocity of the air stream is arrived at by consideration of the average size and weight of the individual particles, and must be great enough to equal the free-falling velocity of the material, plus a velocity of 40 to 60 fps, depending on many variables that do exist. It is important that the material be suspended in the air stream as completely as possible; this lowers friction losses and prolongs pipe life.

But velocity alone is not the sole consideration in the design of a pneumatic system. For example, if an air stream with a velocity of 90 fps will readily convey, say, 5 tons of wood chips per hr, it does not necessarily fol-

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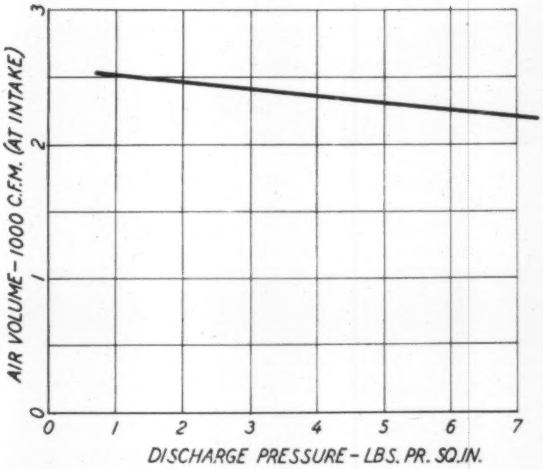


Fig. 2 Characteristic curve showing output of positive-displacement compressor at constant rpm

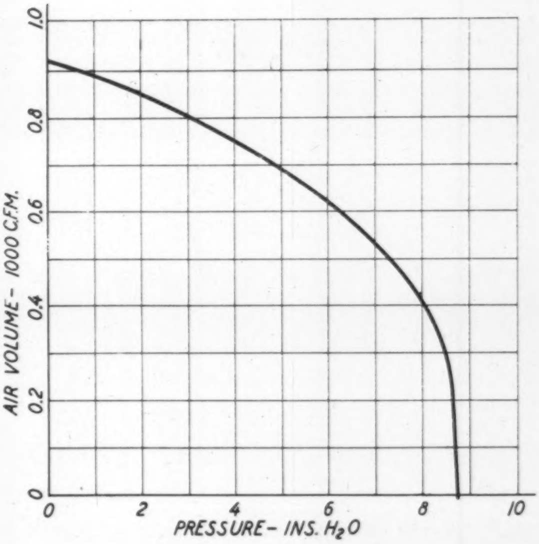


Fig. 3 Characteristic curve on centrifugal fan at constant rpm

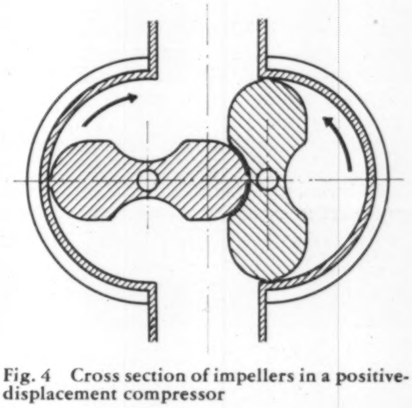


Fig. 4 Cross section of impellers in a positive-displacement compressor

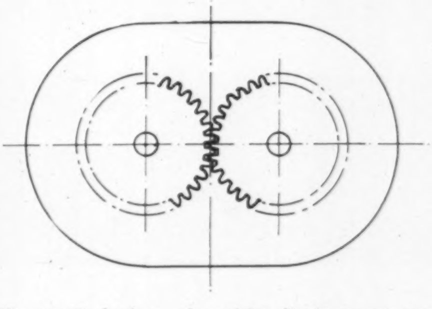


Fig. 5 End view of positive-displacement compressor showing gearing of the impellers

low that the same air stream will convey 30 tons per hr the same distance. It would be necessary to increase the air-to-material ratio, or the air-stream velocity, or both. In other words, any air stream has a definite saturation point, beyond which material will tend to drop out of suspension. Also, the denser the air, the more effective it is as a conveying medium.

In addition to these factors, other problems do develop when material, such as wood chips, is to be conveyed horizontally a long distance, say, 3000 to 4000 ft. Because of the gravitational effect it becomes necessary to make certain that the velocity of the air stream is above the laminar velocity. Or, stated differently, we have found that if there is a reasonable amount of turbulence in the air stream the gravitational effect can be discounted for all practical purposes.

Introduction of Material Into Air Stream

One of the major problems that presented itself in the application of high-pressure conveying in the lumber industry was that of introducing the material into the pressurized air stream. Conventional air-lock or rotary-type feeders were only reasonably adequate. Most of the standard equipment on the market had been designed for uniform free-flowing materials, and were not entirely satisfactory for the handling of a material such as wood chips, which basically has variable particle sizes, and does not flow readily.

This difficulty was not too great when the wood chips were screened, but no conventional designs of feeders would adequately handle unscreened chips with the fairly large incidence of oversized chips. Several different designs were used, one of which was a rubber-tipped feeder. The idea behind the design was that the oversized material would not bind or freeze the feeder rotor because of the flexible tip.

But no equipment available proved entirely satisfactory or trouble-free. After a considerable amount of experimenting our chief engineer designed a rotary star feeder that has proved very satisfactory in the field. Basically, he took a rotary star feeder but designed vanes with a lead of about 1 in. He then incorporated a chipper-type knife into the feeder opening, and the result was a unit with a definite shearing action that was able to shear any "overs" occurring in unscreened wood chips. These feeders also incorporate a positive method of venting the return air, and because of dust conditions that normally exist, the end bells are pressurized.

These feeders are now also being used for hogged fuel with great success. Forty to fifty of these units are now in operation in the Northwestern States. Fig. 6 illustrates the general design of this feeder.

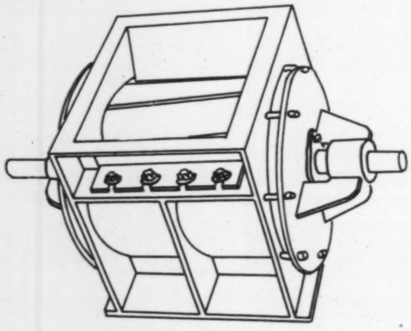


Fig. 6 Rotary star feeder used for introducing material into pressurized air stream

Metering of Wood Chips

Coupled with the difficulty of introducing wood chips into the air stream was the problem of metering or "averaging out" the flow of material. Most of the standard makes of chippers will produce wood chips at peak rates of from five to six times their average output. Therefore, when a pneumatic system was used to transport the output of a chipper, one of two alternatives presented itself—the pneumatic system could be designed to handle the peak rates of flow, or some form of surge bin could be introduced between the chipper and the pneumatic system.

The latter arrangement is, of course, almost always very much more economical. A surge bin, with a metering device feeding the pneumatic system at a uniform rate, is much less costly than a pneumatic system overdesigned five or six times. Not only is the first cost of such a system much greater, but the connected horsepower is correspondingly high, with its attendant high operating cost, and the power-factor problems that develop.

With very few exceptions, most plants using a high-pressure conveying system incorporate some form of surge bin and metering device between the chipper and the high-pressure feeder. A uniform flow of material to the feeder is essential for the most efficient and economical design of the pneumatic system.

Cost Comparison With Belt Conveyers

It is impossible to make an accurate cost comparison with belt conveyers and pneumatic systems because of the many different designs of belt conveyers that are used. However, from what information we have been able to obtain from many different types of operations, it would appear that a reasonably conservative figure for the cost of an average complete conveyer-belt system would be in the neighborhood of $40 per ft.

Based on this figure of $40 per ft, for distances up to 150 to 170 ft, a belt system is more economical in first cost than a pneumatic conveyer. However, for greater distances, first-cost advantage swings rapidly in favor of pneumatic conveying. If the distance involved is in the range of 600 to 700 ft, then the belt conveyer would initially cost approximately twice as much as an air system.

Pneumatic conveyers require relatively large amounts of power; for example, to move 15 tons per hr of wood chips a distance of 500 ft would require approximately 50 hp. However, they do have the great advantage of flexibility. The pipe may be run underground, around corners, or over buildings or obstructions, and can satisfy conditions impossible for any type of mechanical conveyer. To compensate further for the greater operating cost for power they are basically dustless in operation and do not take up valuable yard or building space, and maintenance is at a minimum.

Special Applications

In the Northwestern States it is customary for the freight rates for wood chips to be on a volume or "per car" basis. With this type of freight-rate structure it was apparent that if a greater weight of wood chips could be loaded into a given-size boxcar there would be a definite freight saving.

It was found in some of the first installations that, by loading with a high-pressure air stream, wood chips could be more densely loaded or "compacted." One of the first to recognize this advantage was Potlatch Forests Inc., at Lewiston, Idaho, and, to our knowledge, it was the first concern to include high-pressure systems for the loading of chip cars as a standard component of a chip operation.

After Potlatch had installed 7 or 8 of these pneumatic loading systems, others (especially the pulp mills which were buying chips in quantity) became interested in this "compaction" of wood chips. Notable among these was the Longview Fibre Company at Longview, Wash., which ran fairly elaborate tests to determine what compaction could be obtained. The first results indicated that as much as 20 to 22 per cent more weight of chips could be loaded into a car, as compared to conventional gravity loading.

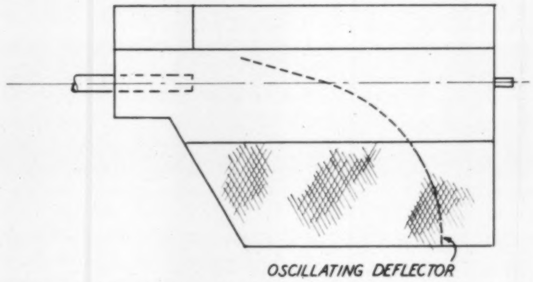


Fig. 7 Cross section of compacting loader used to spread chips uniformly across car

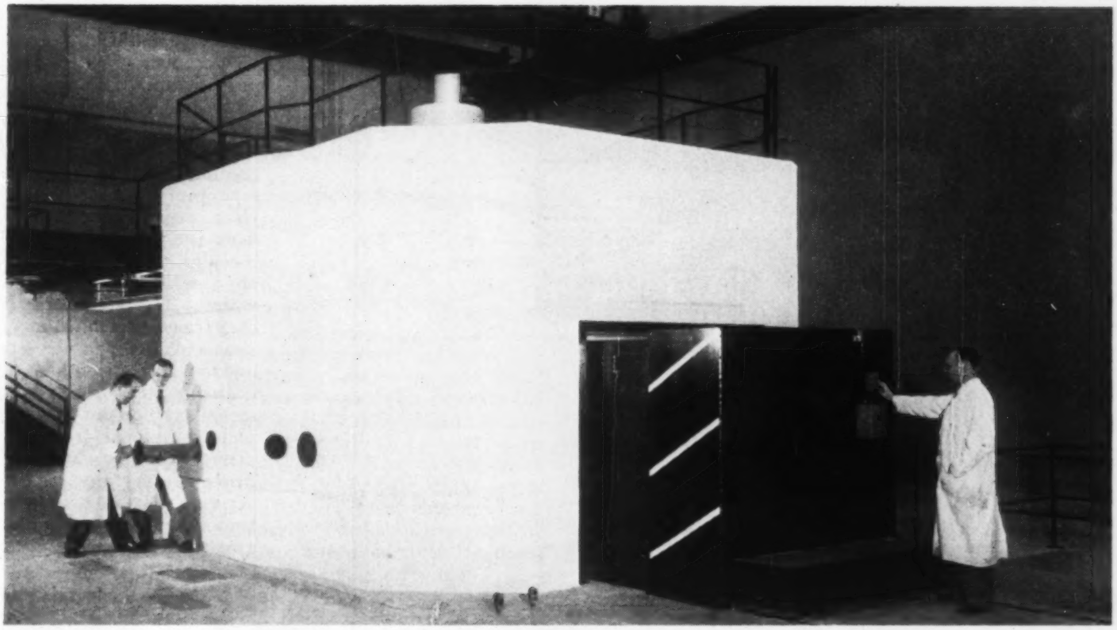
This generally quickened interest in high-pressure conveying. After a considerable amount of experimentation we came to the conclusion that maximum compaction could be obtained only by spreading the chips in uniform layers across the length, and across the width, of the car. Many types of loading arrangements were tried, but one of the more recent designs is illustrated

(*Continued on page 735*)

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., ***Acting Editor***



Technicians, *left*, check a shielding plug in one of the experimental ports of the world's first private nuclear reactor for industrial research, constructed at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. The reactor was designed and built by Atomics International, a division of North American Aviation, Inc. Scientist at right inspects the mechanism that closes and opens the 40,000-lb door of the reactor.

Industrial Research Reactor

OPERATION of the first nuclear reactor built solely for private industrial research began recently in Chicago, Ill. The 50,000-watt research reactor was designed and built by Atomics International, a division of North American Aviation, Inc., for the Armour Research Foundation.

Located on the Illinois Institute of Technology campus, the reactor opens an entirely new field in industrial research and development by providing an on-the-spot source of high-energy gamma rays and neutrons. Short-lived radioisotopes, useful in medical, industrial, and scientific research, will be available locally from the reactor. It will not be used to generate electrical power.

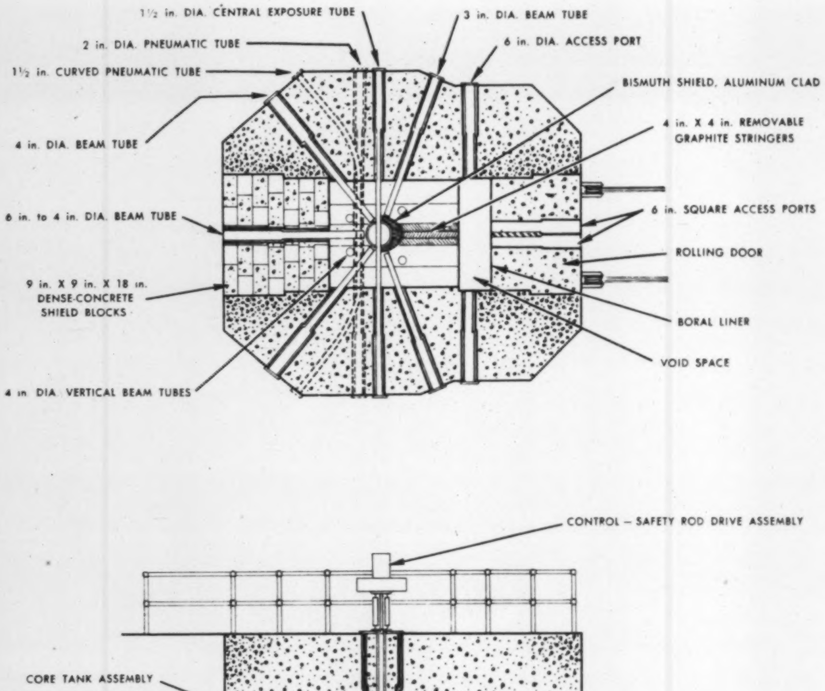
Reactor Description and Operation

The reactor is a homogeneous solution-type reactor, designed to operate at 50 kw and to produce a maximum thermal neutron flux of about 1.7×10^{12} neutrons per cm^2-sec at the center of the reactor core. The reactor consists of a core assembly, gas-handling, fuel-handling, and cooling systems, a control and safety-rod system, and a reflector assembly, together with the necessary instrumentation and shielding for safe and efficient operation. In addition, exposure facilities are provided through which the neutron flux and gamma-ray radiation are available in various intensities for experimental purposes.

The core assembly contains the fuel, which serves as the primary power source, and the moderator, which controls the neutron speed. The fuel consists of enriched uranium, in the form of uranyl sulphate, dissolved in ordinary water, which serves as moderator. The core assembly includes a spherical stainless-steel tank containing four control-rod thimbles which project vertically into the tank, central exposure tubes which extend horizontally through the center of the tank, cooling coils, a line for filling and draining fuel solution, and a gas outlet tube leading to the solution overflow tank and the gas-handling system.

The gas-handling system controls and processes the gaseous products generated within the fuel solution contained in the core tank. The system consists essentially of the recombiner assembly, which is located below the reactor in the subpile room, which is below the reactor, and piping connecting the recombiner to the core tank. The principle functions of this system are (1) to recombine the hydrogen and oxygen which are produced by radiolysis of the solution water and return the resulting water to the core tank, and (2) to confine the radioactive fission-product gases and provide for their disposal, when necessary.

The fuel-handling system provides a means of filling and draining the core tank. The system consists of a safe-geometry storage tank located in the subpile room, and the piping and valving connecting the tank to the reactor core and to the external servicing connections. The tank, which is shielded by lead bricks, is designed for complete subcriticality, even when it contains all of the core solution.


1½ in. DIA. CENTRAL EXPOSURE TUBE
2 in. DIA. PNEUMATIC TUBE
1½ in. CURVED PNEUMATIC TUBE
4 in. DIA. BEAM TUBE
6 in. to 4 in. DIA. BEAM TUBE
9 in. X 9 in. X 18 in. DENSE-CONCRETE SHIELD BLOCKS
4 in. DIA. VERTICAL BEAM TUBES
3 in. DIA. BEAM TUBE
6 in. DIA. ACCESS PORT
BISMUTH SHIELD, ALUMINUM CLAD
4 in. X 4 in. REMOVABLE GRAPHITE STRINGERS
6 in. SQUARE ACCESS PORTS
ROLLING DOOR
BORAL LINER
VOID SPACE
CONTROL – SAFETY ROD DRIVE ASSEMBLY
CORE TANK ASSEMBLY
SECONDARY ENCLOSURE ENVELOPE
GRAPHITE THERMAL COLUMN
LEAD SHIELD
LOCATION OF ION AND FISSION CHAMBER ASSEMBLIES
GAS RECOMBINER
BEAM CATCHER
LEAD SHIELD

Sectional views of Armour Research Foundation's reactor, showing general arrangement of major components. Plan view, *above,* shows beam tubes and thermal column extending outward from reactor core through the dense concrete biological shield. These facilities provide controlled access to neutrons and gamma rays produced in the core. Vertical view, *below,* shows core tank, in *center,* imbedded in reflector, which is composed of graphite blocks. Control and safety-rod system extends upward from core into reactor room, and piping leads downward from core into subpile room, which contains the fuel-handling, gas-handling, and cooling systems (not shown). Entire structure is enclosed in a thick shield of dense concrete.

The cooling system maintains all significant reactor temperatures at their proper values. The system includes a primary coolant pump, the main and recombiner heat exchangers, core cooling coils, and the necessary piping and valving. Heat energy is removed from the core and recombiner by the primary coolant, which is distilled water. The heat energy is then transferred in the main heat exchanger to the secondary coolant, which is ordinary city water. The secondary coolant is completely isolated from the primary coolant water, and hence from any radioactivity. It is also continuously monitored so that a malfunction in the cooling system will automatically close it off from the city water and sewage system.

The control and safety-rod system consists of four boron-carbide cylinders and the appropriate control mechanisms and circuitry to position the cylinders within the reactor core. These cylinders, or rods, absorb neutrons and thus control the intensity of the fission reaction. One of the four rods is driven by a servo-controlled motor and functions as the automatic regulating rod. Each control rod is held to its drive mechanism by an electromagnet located at the bottom of the drive mechanism. When it is desired to "scram" the reactor the electromagnets are de-energized, thus permitting the rods to fall freely by gravity into the control-rod thimbles extending within the core tank.

The reflector assembly increases the efficiency of reactor operation by confining neutron activity to the reactor core. The reflector consists of rectangular graphite blocks which are stacked in layers around the core assembly. These blocks form a rectangular prism about 6 $^1/_2$ ft × 5 ft × 5 ft which is enclosed in a steel shielding tank.

Shielding for the reactor is provided by a 5-ft-thick biological shield of dense hematite-colmanite concrete which surrounds the reflector and the subpile room. In addition, lead shields and bismuth windows are provided for special shielding purposes, as required. The concrete shielding is sufficient to reduce radiation levels at the outer surface to less than one tenth of the generally accepted safe dosage rate specified for laboratories handling radioactivity.

The instrumentation system consists principally of circuits which monitor reactor power and the performance of the gas-handling and cooling system. In addition, there are instruments associated with other important variables, and there is provision for area radiation monitoring and similar instrumentation.

Power level is measured by fission chambers and gamma-compensated ion chambers. Temperature, pressure, and flow-measuring instruments for gas-handling and cooling-system monitoring include instruments measuring sweep-gas flow, core temperature, catalyst-bed temperature, recombiner gas pressure, hydrogen concentration, sweep-gas temperature, and surge-tank level.

The reactor is shut down automatically in the event the flux level or change in flux level exceeds present values, if a malfunction occurs in the auxiliary equipment, or in the event of a power failure. The shutdown is accomplished by circuits which de-energize the magnets which hold the control and safety rods, causing them to fall by gravity into the core. When shutdown occurs, instruments on the control console indicate to the operator the nature and location of the malfunction.

The reactor is located in the new Physics and Electrical Engineering Research Building, which is located at the south end of the Technology Center in Chicago. The reactor is installed in the west end of the building, in a room which is 72 ft long, 48 ft wide, and 30 ft high. The remainder of the building comprises nuclear laboratories and other areas associated with reactor operation.

Use of Reactor Facility

The reactor will produce neutrons and gamma radiation for research and development in the fields of biology, metallurgy, food processing, electronics, chemistry, textiles, oils and gases, rubber and leather, machinery, building materials, and allied industrial and scientific pursuits. In addition, short-lived radioisotopes, useful in medical, industrial, and scientific research but hitherto unavailable because of the time delay in transit, will be available locally from the installation.

As an example of the new and powerful technique made possible by the reactor, "neutron activation" now permits what is probably the most sensitive method of chemical analysis known to date. For many elements, a sensitivity of detection of one-trillionth of a gram can be achieved.

Another newly developed technique is that of "neutron diffraction." Since the diffraction of neutrons is almost independent of atomic number, there is now available a powerful method of structure analysis which complements, and frequently exceeds, the standard x-ray diffraction techniques. This technique has already proved valuable in the study of organic compounds, hydrogen and oxygen in solids, and antiferromagnetic materials.

Physicist at Atomics International checks core for Armour Research Foundation's nuclear research reactor. Atomic fission, the "splitting" of atoms which produces radioactivity and neutrons, takes place in this heavy stainless-steel core. The 50,000-watt reactor is located on the Illinois Institute of Technology campus.

Bombardment of materials by radiation produces effects in almost infinite variety—usually deleterious, but occasionally beneficial. The study of such effects in glasses, plastics, organic systems, and metallic alloys can be undertaken readily with the reactor. The flux also will permit study of the influence of radiation on chemical reactions, some of which are known to accelerate under these conditions.

Reactor Kinetics

How the branch of reactor theory known as "reactor kinetics" is being used to speed the development and design of water-moderated nuclear reactors in atomic power plants was described recently at the second annual meeting of the American Nuclear Society, in Chicago, Ill., by Dr. A. F. Henry, of Westinghouse Electric Corporation, Pittsburgh, Pa. He explained how the mathematical equations of reactor kinetics were being applied to the analysis of experimental data and to the design of power plants that will convert nuclear energy into usable power more efficiently, economically, and safely.

Such information, he emphasized, was particularly vital in the study of reactor accident prevention. He said, "Reactor kinetics can be used to study theoretically how an accident might happen. What we do then is to try to design the plant so that an accident like reactor runaway cannot happen."

Dr. Henry described how the theory had pointed out the built-in automatic stability of water-moderated reactors.

"Our equations," he said, "predict that as the temperature of water in the reactor rises, the fluid will expand so much that too few neutrons will remain in the core to sustain a chain reactor. Experiments have confirmed this phenomenon. As a result, we feel that even if all the safety devices fail to function, a water-moderated reactor will still automatically shut itself down as the water reaches higher temperatures."

According to Dr. Henry, this inherent stability was a characteristic of many types of reactors currently under study in the United States, such as the pressurized water reactor, boiling water reactors, and homogeneous reactors that use a water moderator.

This unique characteristic of inherent stability might some day be used instead of metal control rods to control the output of nuclear power plants, Dr. Henry pointed out.

He said, "Instead of being forced to use relatively rare, expensive, and hard-to-work control materials like hafnium metal to absorb extra neutrons, we may in the future be able to operate power reactors with steam control rods which get rid of the extra neutrons by letting them 'leak' out of the core. At present such an idea presents serious difficulties, but we are studying them and it appears that there is a good chance that we shall be able to solve the problems reasonably soon."

In reviewing the field of reactor kinetics, Dr. Henry first described how the kinetic behavior of a reactor can be used as a research tool to understand basic characteristics of any chain-reacting system. By allowing scientists to measure basic characteristics, reactor kinetics gives them a method of checking theoretical calculations.

"Reactor kinetics," he explained, "is the study of how a reactor and its associated power plant behave in time. In plants where water is pumped through the reactor core to remove the heat produced by fissioning there is a strong interaction between the temperature of the water and the criticality of the core. (A core in which a self-sustaining chain reaction is taking place is said to be critical.) This interaction occurs because the hydrogen in water prevents the neutrons produced by fission from 'leaking' out of the core and thus keeps them near the uranium where they will cause further fissions. Raising the temperature of this water causes it to expand so that more neutrons 'leak' out of the core and the chain reaction cannot be sustained. In reactor kinetics we develop equations which describe this situation and thus predict how the power of the nuclear core will change under a variety of conditions."

Dr. Henry also discussed how these kinetic properties can be applied to reactor design, both in accident studies and to extend design limitations. He said that by indicating potential improvements, reactor kinetics is helping advance the design of current power reactors and is supplying new ideas and information on how to control power reactors.

Neutrino Detected

The Los Alamos Scientific Laboratory, Los Alamos, N. M., operated by the University of California for the AEC, announced that a group of scientists led by Frederick Reines and Clyde Cowan, Jr., has collected experimental evidence for the existence of the free neutrino, a particle without electrical charge and with vanishingly small mass. Over 20 years ago Nobel laureates Enrico Fermi and Wolfgang Pauli theorized on the existence of such a particle in order to account for the mysterious disappearance of energy from a radioactive process known as beta decay. However, the neutrino has hitherto escaped the direct detection deemed necessary to prove its existence in the free state away from the radioactive atom from which it is emitted.

Cowan and Reines believe they first observed the neutrino in the spring of 1953 when, with the help of another group of scientists, they set up near an atomic production reactor at the Hanford, Washington, plant of the Atomic Energy Commission, a large and rather novel liquid-scintillation system as a sensitive detector for the tiny particle. Although the evidence obtained at Hanford was indicative of the neutrino's existence as a particle in the free state, the experiment was not entirely conclusive. The physicists returned to Los Alamos and devised a more complex detecting system which, they hoped, would better select the neutrino signals from the confusing background due to radioactivity and cosmic rays. Last fall the new equipment was taken to the Savannah River Plant, South Carolina, operated by the Du Pont Company for the Atomic Energy Commission, and set up deep underground near one of the large reactors there. After several months of working with the equipment, the scientists feel they have now checked each important characteristic of the neutrinos caught in their detector.

The neutrino interacts only very weakly with material and could be expected to penetrate a distance of many light years through solid matter. Consequently, the detector developed by the Los Alamos scientists is of extraordinary design. In it more than 100 gal of ordinary water containing a dissolved cadmium salt served as a target for the neutrinos coming from the reactor. This target was "watched" by a scintillation system which is in principle like the scintillation detector used by uranium prospectors but which contained over 1000 gal of sensitive liquid and 330 large photoelectric eyes, called photomultiplier tubes. Despite its huge size and the many billions of neutrinos from the reactor which passed through it each second, only a few neutrino captures were observed in the target water each hour.

This discovery marks the first time that man has knowingly caused a direct reversal of the radioactive process called beta-decay. In the present experiment, normally stable protons (hydrogen atoms in the water) were made to absorb a neutrino, emit a positive electron, and become neutrons. Thus a particle with the expected properties of the neutrino has been detected in an inverse beta-decay reaction, the theory of Fermi and Pauli may be considered as proved, and nuclear scientists may accept with some confidence the further theories which have been developed involving the neutrino.

They may also avail themselves of the neutrino to assist them in the understanding of the atomic nucleus and of the constitution of the universe.

Lubrication-Free Bearings

The need for conventional lubrication in many types of bearings may be eliminated by a new automobile suspension joint that was announced recently.

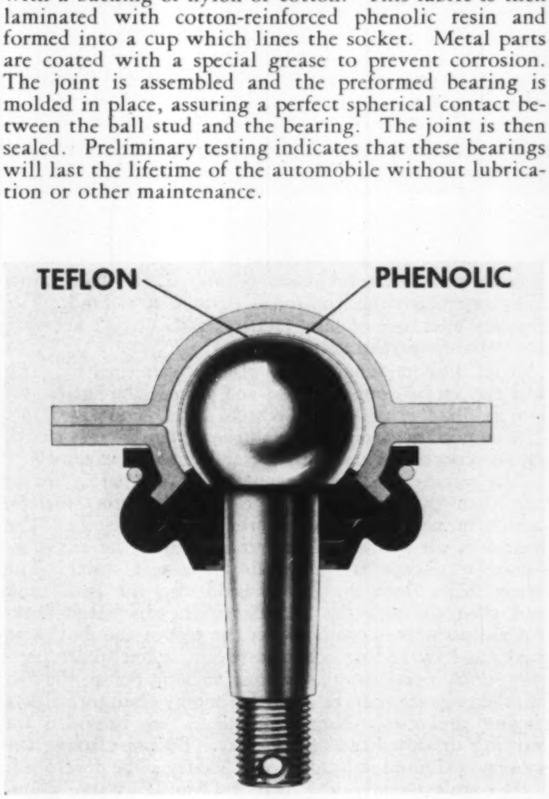
Key to this development is the use of "Teflon" tetrafluoroethylene fiber woven into fabric. Teflon is said to be one of the most slippery materials known.

Use of fabric of Teflon fiber to face metal suspension joints, in addition to functioning without customary lubrication, reduces the amount of friction by more than 50 per cent in comparison with standard lubricated suspension joints used in today's automobiles.

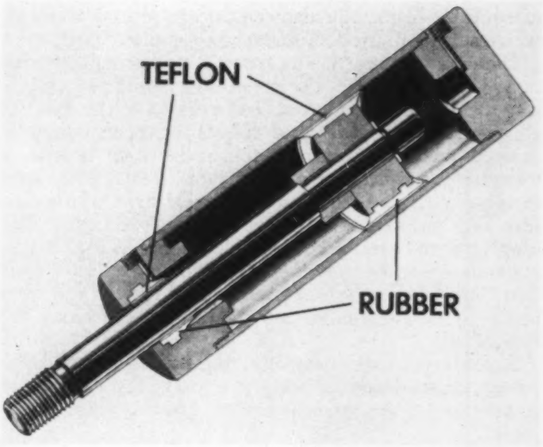
This use for Teflon fiber was developed by the American Metal Products Company of Detroit, Mich. Du Pont, originator of Teflon, co-operated in developing this use for the versatile synthetic fiber.

To date, efforts have been directed mainly toward improved front and rear suspension components for automobiles. Several automobile manufacturers have AMP assemblies on test.

Use of Teflon tetrafluoroethylene fiber in a ball-and-socket suspension joint is achieved by double weaving it with a backing of nylon or cotton. This fabric is then laminated with cotton-reinforced phenolic resin and formed into a cup which lines the socket. Metal parts are coated with a special grease to prevent corrosion. The joint is assembled and the preformed bearing is molded in place, assuring a perfect spherical contact between the ball stud and the bearing. The joint is then sealed. Preliminary testing indicates that these bearings will last the lifetime of the automobile without lubrication or other maintenance.



Cross section of suspension ball joint showing facing of Teflon fiber.



Typical application of Teflon fiber in a flexible bushing and seal.

Studies indicate that there will be no increase in original cost over a standard joint.

Many other frictional applications of Teflon fiber which may eliminate the need for conventional lubrication are under development. These include:

1 Spherical parts such as rod ends and ball-socket joints for special controls and self-aligning bearings.

2 Cylindrical parts such as seals, bushings, pistons, and sleeve bearings for all types of machinery, marine propeller shaft bearings, and steel roller mill bearings.

3 Flat or sliding parts, such as leaf-spring end pads and slider beds for adjustable seats and conveyer belts.

This development represents a new tool for the design engineer to use in solving many mechanical problems, such as lubrication of hard-to-reach parts, and operation of frictional parts in extreme temperatures, and in corrosive chemical environments. One promising use is in bearings and other frictional parts on food and textile processing machinery where contamination of the product from lubricants is a problem. The new principle is expected to be used primarily in bearings and joints subject to intermittent motion. Conventional lubrication appears to enjoy advantages in bearings subject to continuous motion in one direction, at high speed under high load.

New Lubrication Pad

A new journal box lubrication pad has been announced by Spring Packing Corporation, Chicago, Ill. The lubrication pad, it is claimed, will virtually eliminate "hot boxes"—one of the most costly and disastrous single things that has always plagued the railroads.

Hot boxes occur most frequently on freight cars because of the greater weight loads, greater impacts in yard-switching and hump operations, and varying operating conditions. One railroad alone reports that hot boxes are directly responsible for annual losses totaling $4 million. A conservative estimate of the average expense of a single hot box is $250. A hot box means the complete loss of perishable freight and a complete failure of a train to meet factory delivery schedules. A hot box also can cause a serious accident, even resulting in the derailment of a complete train.

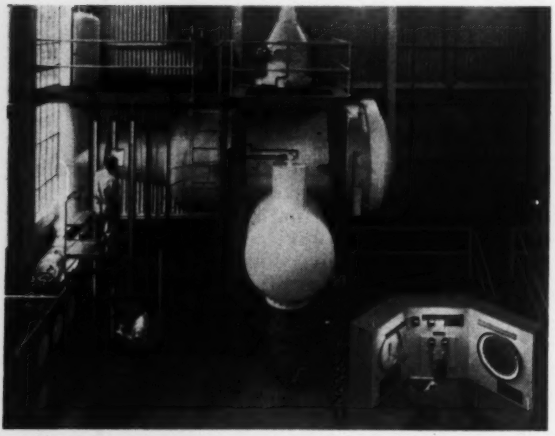
The pad is built around a special steel spring construction which eliminates the possibility of the pad collapsing away from the journal (end portion of the axle) at all times. Over this is a canvas wrapper which is covered with an absorbent felt pad which acts as a reservoir regardless of temperature. Inside the steel spring is a core of cured curled animal hair. This also acts as a reservoir and keeps the pad resilient. The tough cotton outer jacket was selected for its high wicking action. It will not glaze and is lint-free—an important consideration because even a small piece of thread or lint between the journal and the bearing can block the flow of oil.

According to the company, the lubrication pad has passed all road and laboratory tests. (Tests were just completed at the Association of American Railroads' center.)

Hydraulic Turbine-Testing Laboratory

A NEW high-head turbine-testing laboratory, now in operation, has been developed by the S. Morgan Smith Company, York, Pa. The feature of this test stand, an addition to the company's original laboratory, is its ability to duplicate actual field conditions, by pressurizing small-scale power-plant systems, for all Kaplan turbine applications likely to be encountered anywhere in the world, and for some Francis turbine designs.

Turbine-testing laboratories are essential because on many field installations, particularly for large Kaplan and propeller turbines, it is impossible to conduct a reasonably accurate field acceptance test in accordance with any approved test code. The effective head and horsepower output present no special problems, but accurate measurement of the large quantities of water involved is not economically feasible. Consequently, the turbine manufacturer makes his guarantees on the basis of previous tests on similar models, with an accurately conducted laboratory test on a completely homologous model including spiral-case and draft-tube, run after the contract award to confirm the guarantees and obviate field testing.



S. Morgan Smith Company's hydraulic-turbine-testing laboratory, showing control panel, gages, and testing chambers.

Exact scale models are tested for efficiency, power, discharge, and other hydraulic criteria. Different components and mechanical variations which may improve performance are also examined. Since the advent of very large hydroelectric units in the 1920's, hydraulic turbine manufacturers have experienced little difficulty in designing and building units capable of attaining 93 to 94 per cent efficiency. The major field of exploration in the laboratory, therefore, has been the development of runners which will resist the phenomenon known as cavitation.

Cavitation is pitting of the runners due to shock pressure concentrations of great intensity. Cavitation begins when the absolute pressure at any point on the runner vanes drops below the vapor pressure of the water, resulting in the formation of numerous tiny bubbles filled with water vapor. These bubbles are carried quickly to areas of higher pressure when they collapse suddenly, producing shock pressure concentrations of terrific intensity which eventually destroy the metal surface and cause pitting.

The Thoma cavitation index, sigma, is used to define the cavitation characteristics of a turbine. Sigma is defined as the ratio of the barometric head minus the static suction head at any point to the total operation head on the turbine. To determine the minimum allowable or critical sigma in the laboratory, the model is usually tested with a constant wicket gate opening (and blade angle in the case of a Kaplan turbine) at a constant speed under a constant head while the elevations of headwater and tailwater are lowered step by step for successive runs until a definite break or change in performance is observed. In practice a reasonable margin of safety above this break determines the operating limit for the corresponding head and load on the prototype. When the plant sigma drops below the critical sigma for any head and load, pitting, vibration, and loss of output will result.

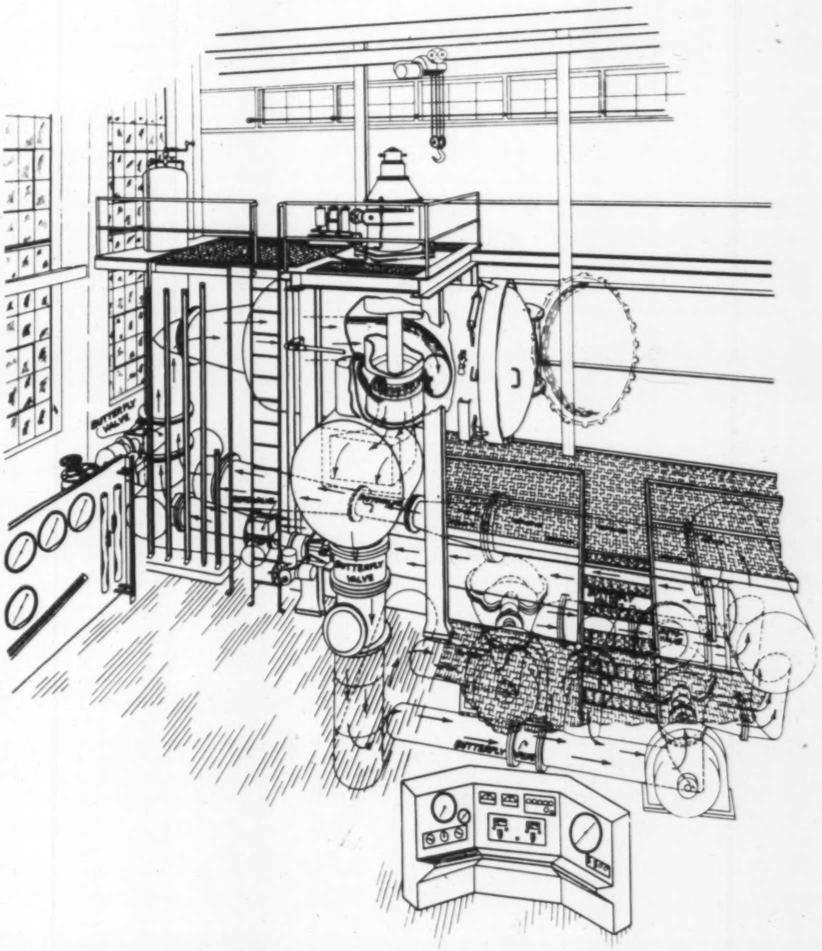
To correct early laboratory difficulties in obtaining definite cavitation break-off points, S. Morgan Smith has constructed the high-head turbine test stand. The primary function of this facility is to obtain accurate and reliable quantitative results.

After the complete model is assembled in the head tank and the access door is closed and sealed, the entire system is filled with water (which takes about 15 min). The pumps are then started and the system is pressurized. All mercury and water manometers are bled and zeroed.

The pumps discharge water into a discharge header and then through either of the two Venturi meters, which measure the flow to the Venturi header. The header is used as a collector from which the air is allowed to escape when starting the test stand. The water flows from the intake header to the head tank and then through the turbine to the discharge tank. An air cushion is provided on the top of the discharge tank, and by adding compressed air, water under pressure, or by evacuating air with a vacuum pump, the discharge pressure may be altered, thereby changing sigma during the tests. Numerous valves are provided for varying the test head on the unit. By pressurizing the system, a simulated head of over 300 ft can be developed.

The scale models used have a 12-in. discharge diam. Differential mercury manometers are used to measure the net head across the turbine below 150 ft. Heise gages are used to measure the inlet head pressure when the 150-ft differential is exceeded. A mercury "U" tube manometer is used for measuring the discharge tank pressure. A 7-ft-diam head tank is provided in which the wheel case is mounted. The elbow draft tube discharges through the bottom of this tank into the 5-ft-diam discharge tank. A 100-ton water-cooling system is used to maintain the 10,000-gal stand capacity at a constant temperature. The water to be cooled is taken from the high-pressure side of the pumps and returned to the suction side.

Five men are used to conduct a cavitation test and are located at the following stations: Dynamometer control panel, Venturi manometer, headwater manometer, tailwater manometer, and the computer's desk. A number of simultaneous readings are taken on all gages during a run. Direct manometer reading is readily understood and allows cross-checking by the hydraulic laboratory technicians, the company's hydraulic engineers, and visiting customer's engineers during acceptance tests. Upon completion of a test, the stand can be shut down, drained, and the runner removed in less than an hour.



Cutaway view of high-head turbine-testing laboratory with arrows showing the flow of water through discharge header, Venturi meters, Venturi header, head tank, turbine, and discharge tank

Through the facilities of the turbine-testing laboratory, operating companies can purchase units of higher speeds and smaller diameters at reasonable settings and effect the economies of smaller generators and power houses, as well as less excavation, without the risk of expensive redesign and revision of massive prototype components in the field.

Zirconium Plant

Production capacity of zirconium, a metal used in atomic reactors, will be increased to over $1^1/_2$ million lb per year with the construction by the Carborundum Company of a new plant in Parkersburg, W. Va. The new plant will be operated by Carborundum Metals Company, Inc., a Carborundum subsidiary.

Announcement of the new plant came immediately after confirmation that the Atomic Energy Commission had awarded a new contract to Carborundum Metals to supply an additional 500,000 lb of zirconium annually. Presently producing 325,000 lb annually for AEC, the new contract increases the company's firm AEC commitments to 825,000 lb of zirconium per year. The new contract also gives AEC priority on an additional 400,000 lb of Carborundum Metals zirconium production—making the company's total firm and conditional commitments 1,225,000 lb of zirconium per year for AEC.

The capacity of the new plant coupled with production at Akron, N. Y., makes it possible for Carborundum Metals to meet its AEC contracts and also give firm commitments now for delivery of zirconium in 1957 and 1958 to commercial users in the domestic and foreign markets

Carborundum Metals is also expanding its plant and adding new facilities at Akron, N. Y. A new building is being constructed for the installation of a melting unit capable of melting zirconium and zirconium alloy ingots up to 3000 lb each. This facility is scheduled for operation this month.

Carborundum's production of zirconium will be fully integrated. Zircon sand from the beaches of Florida will be processed through all stages, including separation of hafnium from the zirconium, purification, reduction to sponge, and double-arc melting into zirconium ingots ready for forging, rolling, and fabricating into end products for atomic reactors and industrial applications.

Many commercial applications of zirconium in the chemical processing industry do not require hafnium-free zirconium. This commercial-grade zirconium, formerly short in supply due to government requirements for reactor-grade zirconium, will be available in adequate volume with the operation of the new plant, the company announced.

Super-Alloy

A NEW super-alloy, one application of which is for high-temperature steam turbine blades, was unveiled recently by Westinghouse Research Laboratories of Pittsburgh, Pa. The alloy is the first practical result of a new research technique for "predesigning" metals of the future.

The new alloy—called Nivco—was deliberately "predesigned" to have high strength at temperatures as high as 1200 F, with the ability to resist mechanical vibration. This ability to kill mechanical vibration, called "damping," results from control of the magnetic arrangement of the atoms comprising the alloy and was theoretically "built in" before the metal itself was actually prepared.

The research technique which produced Westinghouse's new super-alloy is a direct result of the company's long-range materials development program. The technique, it was said, permits the predesign of a needed set of properties into an alloy, thereby eliminating the time-consuming "cut-and-try" metallurgical methods usually employed. It promises to speed the discovery of other new alloys and insure that those developed will have the best possible properties within the alloying metals available.

Turbine-Blade Vibration

It was pointed out that turbine blades, rotating at 3600 rpm inside a steam turbine, are subject to tremendous steady and varying forces which tend to make them vibrate. To aid in reducing the amplitude of this vibration, the blades must be artifically damped, or the blade material itself must have self-induced damping so it will minimize vibration and keep the blade within safe limits. At the same time, the metal must retain strength and resistance to corrosion required of all turbine materials operating at higher temperatures.

Present turbine blades, such as 12 per cent chrome steel, have excellent over-all properties up to about 1050 F initial temperature. Above that temperature, however, chrome steel must be used at lower stress levels.

It was recognized, therefore, that improved turbine-blade materials would be required by the larger, higher-temperature turbogenerator units now being developed to realize higher thermal efficiencies for the large-scale generation of electricity.

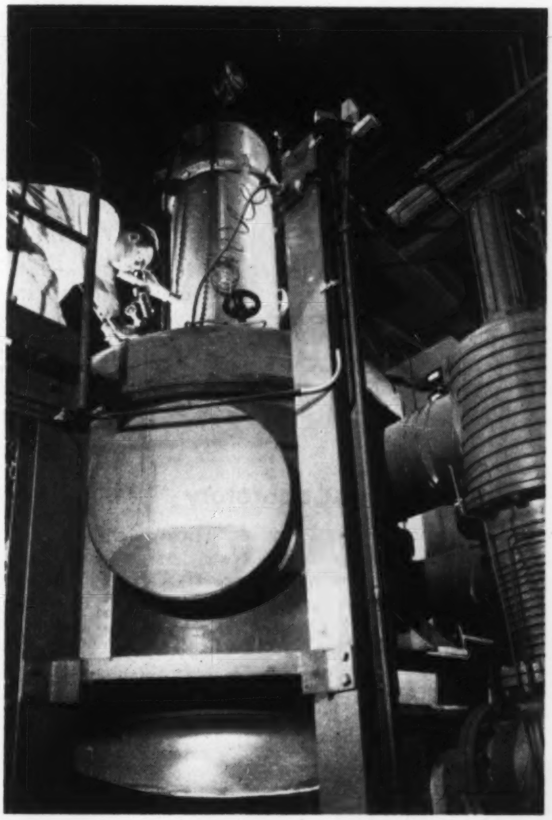
Multiple exposure of ping-pong balls bounced by vibrating tuning forks illustrates comparative damping characteristics of new Westinghouse alloy Nivco and ordinary low-carbon steel. Nivco, *right*, a high-strength alloy for steam turbine blades, damps down within a few seconds. Carbon steel vibrates for several minutes.

Nivco Five Times Stronger Than Chrome Steel

The new alloy promises to be such a material. At 1200 F, it was revealed, Nivco has five times the strength of 12 per cent chrome steel and a damping nearly equal to chrome steel at 900 F.

The mechanical behavior of a given alloy depends, at least in part, on its magnetic properties. Now, after several years of research, Westinghouse has discovered how to design needed mechanical behavior into certain alloys by control of their magnetic structure. Thus, by combining certain metals in different proportions, their behavior can be predicted. This can be done without preparing and testing thousands of potential combinations of two or more alloying metals.

This technique, it is felt, is a forward step in metallurgical research, and this new alloy, the beginning of its application to practical situations.



The new alloy, Nivco, for steam turbine blades is melted and cast into ingots inside this vacuum-melting furnace at the Westinghouse metals plant at Blairsville, Pa. Vacuum heat-treating and melting furnaces are playing a greater and greater role in producing alloys of high purity free of entrapped gases.

Nivco snubs vibration of the turbine blading appreciably simply because its magnetic structure dictates that it cannot vibrate. It is an ability which was consciously predesigned into the metal and was foreseen well before a piece of the metal itself.

Nivco Results of Three-Stage Development

The new alloy was a three-stage research development.

First, an exhaustive study was made of the magneto-mechanical effects in metals, including magnetostriction—the tendency for certain metals to change dimensions under the influence of a magnetic field. This research furnished the basic knowledge needed for predesigning the new alloy.

Second, the theories were tested by preparing and analyzing some 50 different alloys, studying in detail their damping, corrosion resistance, hardness, tensile strength, and ductility.

Third, the strength and corrosion resistance of the highly damped alloys, suggested by the theories and verified by their preparation were perfected. The final result was an alloy which, it is believed, will prove to be an outstanding blading material for the steam turbine of tomorrow.

Although its exact composition was not disclosed, Nivco is composed principally of cobalt and nickel, but it includes certain smaller amounts of five additional elements. The ultimate tensile strength of the metal is about 100,000 psi at 1200 F, at which temperature the metal glows with a dull red heat. The alloy is prepared by melting in a vacuum furnace under an inert atmosphere or argon gas. After melting, it is treated and forged at 2000 F.

Possible Application

One possible application of the new alloy is in the super-pressure turbogenerator now being built by the Westinghouse steam division in Philadelphia.

This 325,000-kw turbogenerator will have the highest operating temperature and pressure as well as the best plant heat rate of any existing or proposed unit for electric utility service, it was pointed out.

The turbine which drives the electric generator will operate at a pressure above the critical pressure of water.

Westinghouse steam engineers have said that Nivco is a natural for this application and will help make possible a major forward step in steam turbine design. While it is expected that this new material will provide a solution of the problem of suitable turbine blade material for several years to come, already better ones are being sought. It is felt that the newly developed metallurgical research technique will be of significant help in bringing along the great variety of new metals and alloys which inevitably will be demanded by the bigger, stronger, more efficient equipment of the future.

High-Temperature Alloys

Two new high-temperature alloys for aircraft and industrial gas-turbine applications have been announced by the International Nickel Company, New York, N. Y.

The first, Inconel "700" age-hardenable nickel-cobalt-chromium alloy, contains approximately 50 per cent nickel and 30 per cent cobalt. This new alloy, a modification of Inco's Inconel "X" high-temperature alloy, was developed by Inco for aircraft designers who were seeking adequate strength for forged aircraft gas-turbine blades at temperatures up to 1650 F. A metal was required that could be operated at a working temperature approximately 150 F higher than the Inconel 'X' alloy.

This nickel-cobalt-chromium alloy is now produced as hot-rolled rounds in the size range of $^5/_8$-in. to 2-in. diameters—all rods are furnished with a turned or ground finish. A small amount of cold-rolled sheet has been produced experimentally. The mechanical properties of the Inconel '700' alloy at 1650 F are very similar to those of Inconel 'X' at 1500 F. The new alloy has enabled aircraft engine builders to either increase the performance of the current engines or to plan the designing of future engines to operate at a higher temperature range.

The second new product, Incoloy "901" nickel-iron-chromium alloy, has been developed for use in aircraft and industrial gas turbines for those components requiring high creep and rupture strength in the temperature range of 1000 to 1400 F. At these temperatures, the Incoloy '901' alloy has properties that compare favorably with those of the super-alloys yet is low in strategic alloy content.

An important physical property of this new alloy is its low coefficient of thermal expansion. Containing approximately 40 per cent nickel, it is close enough to ferritic alloy steels to permit the two materials to be joined without special provision for thermal expansion. In addition to bar and forging stock, the alloy is also produced as sheet in the same sizes and gauges as those offered in Inconel X and Inconel "W" age-hardenable alloys.

Incoloy 901 is expected to find wide application for use in turbine rotor and compressor disks and structural parts calling for an intermediate temperature range of 1000 to 1400 F.

Unitary Plan Wind Tunnel

ENGINE-OPERATING conditions at supersonic speeds and altitudes of 30 miles can be duplicated on the ground in a new wind tunnel at the NACA Lewis Flight Propulsion Laboratory, Cleveland Airport, Ohio.

Now in full operation, the tunnel's 250,000-hp electric-motor drive is the most powerful of its kind in the world. Air speeds range between Mach number 2.0 and 3.5, or between 1200 and 1800 mph at high altitudes.

The 10 × 10-ft Lewis Unitary Plan Supersonic Wind Tunnel, built for development testing of engines and components for high-performance aircraft, is used in cooperation with industry and the armed forces by the National Advisory Committee for Aeronautics.

The new tunnel is valuable especially for work on problems of turbojet and ramjet engines. Engines and components as large as 5 ft in diam may be studied in the 10-ft-sq test section.

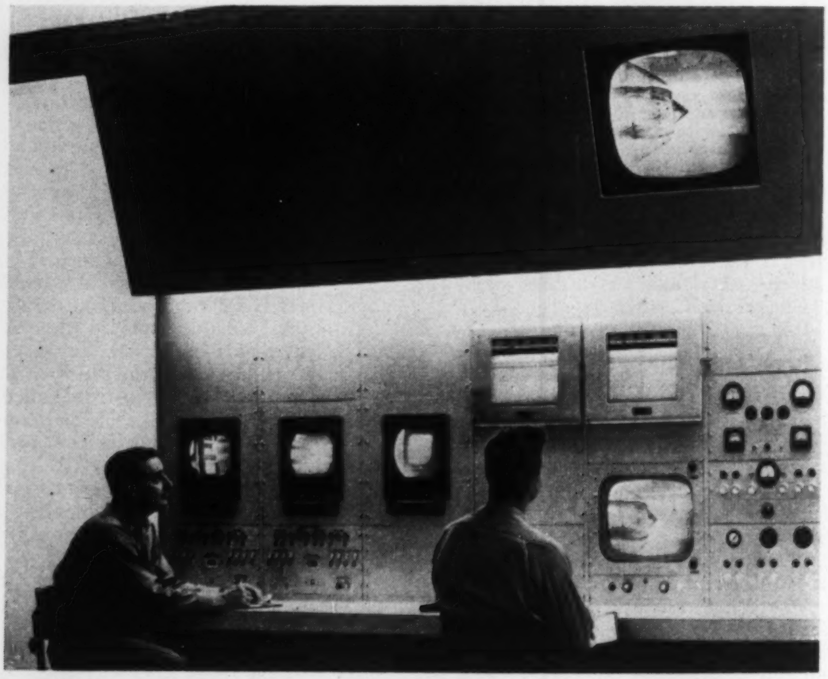
The tunnel may be operated either in closed circuit for aerodynamic tests, or in open-end propulsion circuit, with engines running under combustion test. Its main purpose is investigation of such problems as engine-inlet and outlet geometry, engine matching and interference effects, and over-all drag. Though many tests will be conducted with scale models, the test section can accommodate full-size engines and components.

The Unitary Plan Supersonic Wind Tunnel supplements the Lewis 8 × 6-ft Supersonic Wind Tunnel, which has a Mach number range of 1.4 to 2.0. Experience with that research tool produced large performance gains for the current "century series" fighters, such as the F-102 and F-104. As a result of the significant gains obtained with this tunnel, the larger and higher speed new facility was built.

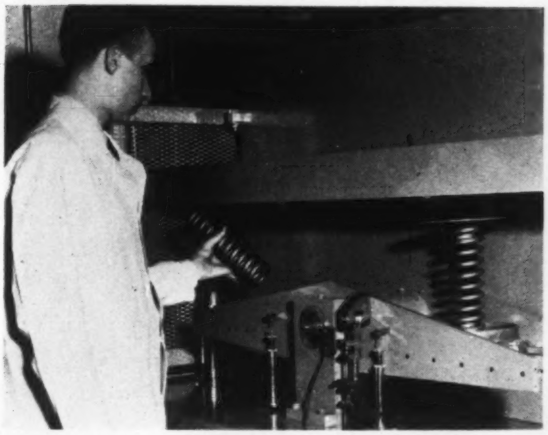
Fatigue Testing Laboratory

To ANSWER questions such as "How much bounce in a spring?", and to provide for customers a more accurate evaluation of other wire products, U. S. Steel's American Steel and Wire Division has established at its Cuyahoga Works in Cleveland, Ohio, a laboratory devoted exclusively to fatigue testing.

For testing helical springs such as automobile valve and front suspension springs, springs for beds, machine



Wind-tunnel tests of aircraft models and engines are observed remotely with RCA closed-circuit television installation at NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio. Research personnel in control room operate and observe performance of model undergoing tests in wind tunnel 250 ft away. Three RCA industrial TV camera chains and four 24-in. TV monitors are utilized to provide safe observation for personnel operating 10 × 10-ft supersonic wind tunnel and conducting research on aircraft engines and propulsion systems.



Heavy railroad coupling springs are loaded for testing in a variable-stroke compression machine at the Fatigue Laboratory of U. S. Steel's American steel and Wire Division in Cleveland, Ohio. This machine can test two springs at a time, each with a compression as high as 7500 lb and at speeds up to 1500 cpm.

guns, railroad cars, and for refrigerator compressors, the laboratory is equipped with four variable-stroke compression machines, one of which is able to test springs made of $^{3}/_{4}$-in-diam wire and having a compression up to 7500 lb. This machine tests two springs at a time and has a variable speed up to 1500 cpm.

In a high wind, transmission cables will "sing" as they vibrate. This vibration of the cable causes it to flex rapidly at all points of support. As these cables are installed for decades of service, the wire must be designed to withstand this flexing action. The laboratory has two vibration machines to simulate, through electromagnetic drive, the action of wind vibration from 1 cycle to 20,000 cps.

Two torsion-spring testers are provided to evaluate springs such as are used in overhead garage doors, wind-up toys, and various other spring-powered equipment. These machines can cycle each spring through any range suitable to determine its life expectancy and load-carrying capacity.

Of the laboratory's two tensile-strength machines, one is unusual. It is horizontal instead of vertical and can take up to 20 ft of sample cable. It has a maximum capacity of 60,000-lb pull.

There are four reverse-bending machines for testing wire from $^{1}/_{4}$-in. in diam down to 0.004 in. The wire to be tested is mounted in a curve and then rotated at speeds up to 20,000 rpm. The wire is run to destruction or to 10,000,000 cycles. Under such reverse stress, it has been found that if the steel can stand up to 10,000,000 cycles, it will withstand almost an infinite number of such stresses. All the machines in the fatigue laboratory, running day and night, automatically record cycles and automatically shut off when the sample test piece fails.

The fatigue laboratory, which operates as part of the metallurgical department, also serves in developing new products. For instance, when airplane manufacturers expressed the need for control cable with expansion characteristics to match that of the aluminum aircraft frame, various metallurgical formulas were tested and modified in line with the laboratory's recommendations. From the joint efforts of testing and metallurgy came a new application of a steel alloy that when fabricated into cable became the well-known Hyco-span aircraft control cable with nonmagnetic qualities and a coefficient of expansion closely approximating that of aluminum alloys used in aircraft construction.

More recently, the laboratory performed a series of load-strain and fatigue studies on galvanized bridge wire. From these studies, engineers were guided in the selection wire for the cables on the new Delaware River Bridge near Philadelphia and on the great span across the Mackinac Straits.

High-Pressure Pneumatic Conveying in the Lumber Industry

(Continued from page 724)

in Fig. 7. The compacting loader incorporates a traveling deflector which moves across the open-top car and spreads the chips uniformly across the width of the car. The loader is used in conjunction with a reversible car haul which automatically moves the car back and forth underneath the loader. This results in the chips being deposited in uniform layers across the whole car area.

Where this additional loading was desired, but where it was impossible to move the car during loading, we designed a loader on the same principle, but with the deflector traveling back and forth along the length of the stationary car. With these loading arrangements for compaction over 30 per cent more weight of material can be loaded into open-top cars, as compared to gravity loading.

Scope and Limitations

The greatest use for pneumatic conveying in the lumber industry has been for the movement of wood chips. However, more and more systems are being installed to handle mill refuse such as hogged fuel, bark, sander dust, shavings, and sawdust. Almost every mill has a refuse-handling problem, and it would appear that it is in this field the greatest developments will take place.

The United States Plywood Corporation at Anderson, Calif., for example, has two 1500-ft systems in operation—one moving sander dust, and the other moving hogged fuel, directly into the boilers.

The question that is most generally asked is: "How far can this type of material be blown?" Theoretically, of course, there is no limit to the distance. However, the largest system we have in operation moves chips from Pope & Talbot's mill at St. Helen's, Ore., a distance of 4700 ft to Crown Zellerbach's storage silos. Depending on many variables it presently would seem that the maximum distance this type of material can be transported economically by air is in the neighborhood of 5000 to 6000 ft.

But, looking back on the developments in this field during the past 2 or 3 years, it is quite possible that pneumatic conveying systems of 5000 or 6000 ft may be quite commonplace a few years from now.

Engineering Developments

. . . at a Glance

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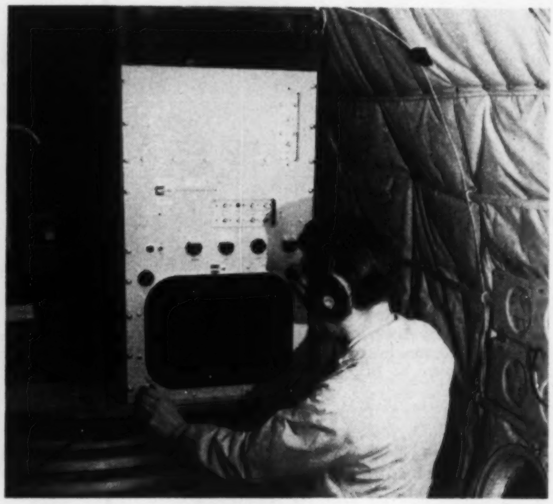
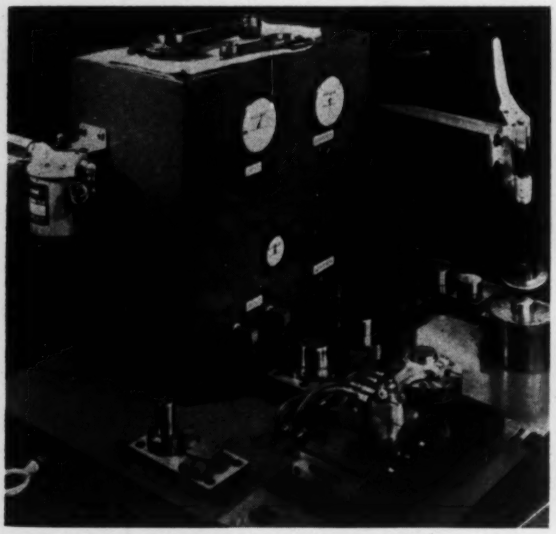
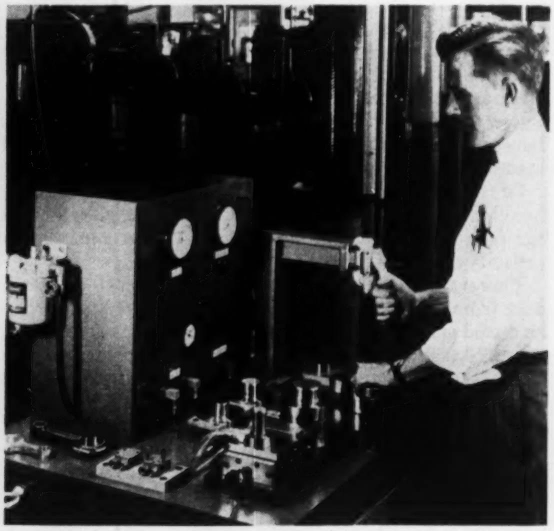
LOCKHEED



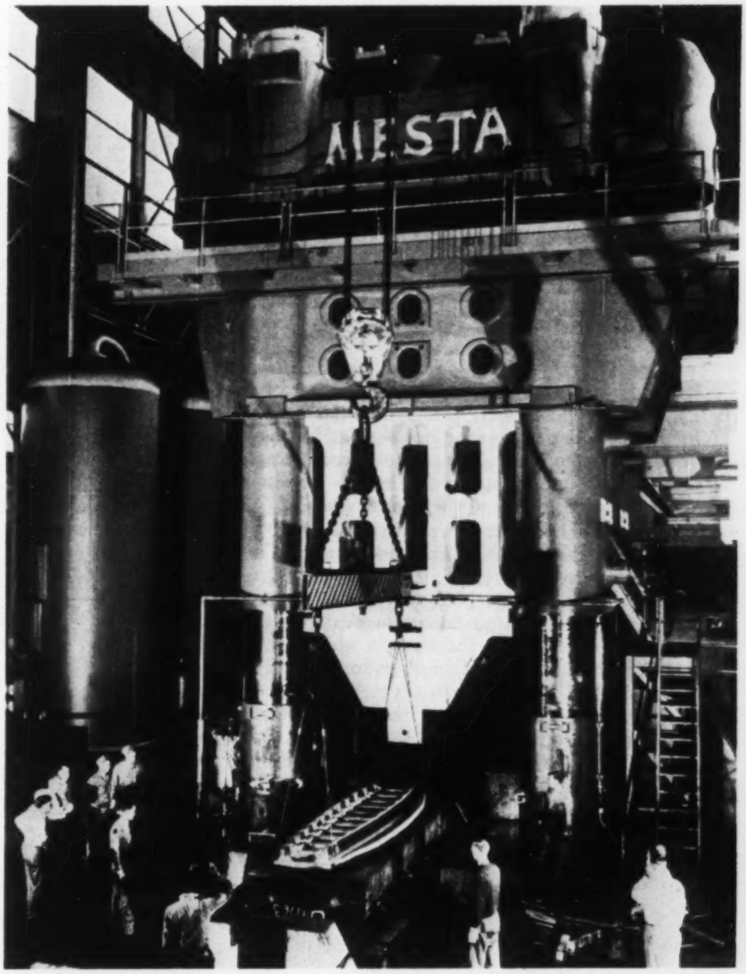
Miniature TV Camera. Electronics engineers at Lockheed Aircraft Corporation, Burbank, Calif., recently reported development of the world's tiniest television camera, only 5 in. long, as the latest scientific tool to flight test the new Electra propjet airliner. The microminiature camera with 8-mm lens weighs only $1^1/_2$ lb. Photo at *left* shows how television cameras are mounted externally to permit continuous study of performance during actual test flights. Here, a technician adjusts the special TV camera on mount beneath tail of Lockheed C-130 propjet combat transport. Televisor relays picture of air-flow tufts attached to tail, and flight-test engineers viewing receiver inside plant *right* can evaluate air-flow pattern. With this hook-up, flight-test engineers can study performance of controls, landing gear doors, and other areas during flight.



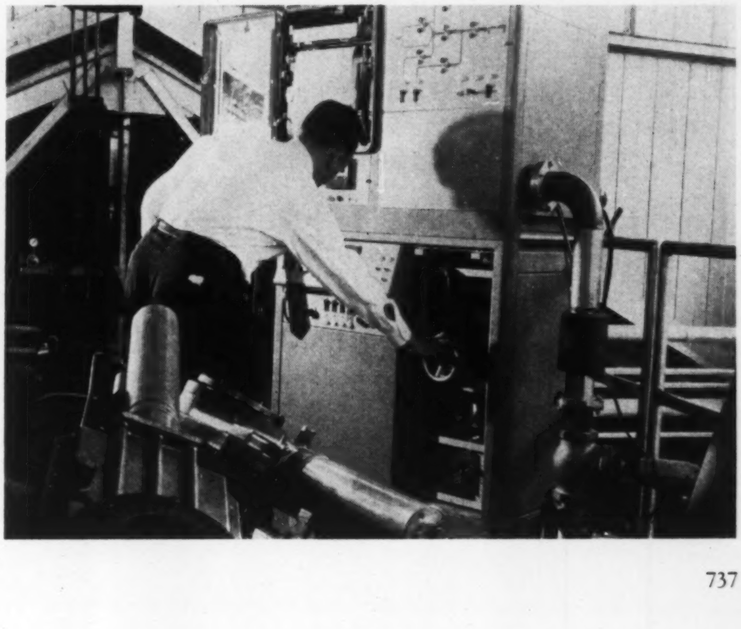


Two-Station Air Gage. This new two-station air gage with interchangeable plugs measures hole alignment and squareness for three sizes of connecting rods. First station (*left*) gages connecting rod for bend by measuring the parallelism of crankshaft and wrist-pin bores. Interchangeable air plugs adapt gage to three different sizes of connecting rods. Crankshaft-bore plug is mounted in fixed position, while plug for wrist-pin bore is mounted in one of the three positions on a spring-loaded slide. Second station (*right*) measures squareness of crankshaft bore to connecting-rod face. Three interchangeable plugs permit gage to check squareness of three different rod sizes.

3000-Lb Closed-Die Forging. World's largest closed-die forging—a 3000-lb aluminum airframe member for the multijet Martin XP6M SeaMaster—is removed from the 50,000-ton press in the Air Force plant at Alcoa's Cleveland, Ohio, works. As it comes from the dies, the huge piece measures 13 ft in length, 3 ft across at its widest point, and 1 ft in thickness. The forging makes possible a substantial weight reduction and a consequent increase in the performance level of the SeaMaster. It offers, in one piece, a part formerly assembled from many smaller components.



Mass Spectrometer. Molecular particles of gases are literally sorted and weighed continuously by this custom-built mass spectrometer, installed recently on the vacuum-melting furnace platform at Carboloy Department of General Electric Company, Detroit, Mich. Built by Consolidated Electrodynamics Corporation, the unit helps determine and control progress of the high-vacuum process by analyzing gases produced in the furnace while special alloys are made.



European Survey

Engineering Progress in the British Isles and Western Europe

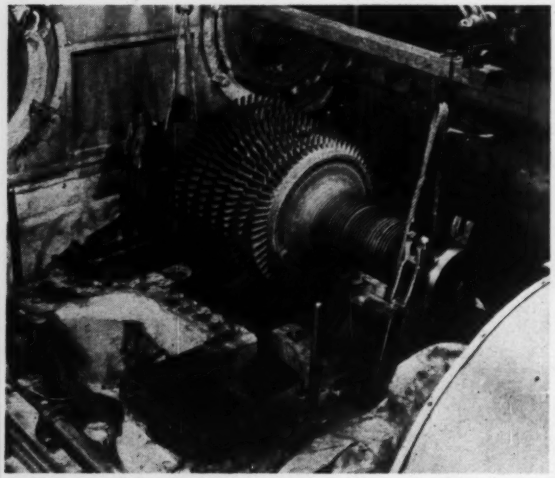
J. Foster Petree,[1] **Mem. ASME,** ***European Correspondent***

Historic Marine Gas Turbine

The "Shell" tanker *Auris*, the first merchant ship to be driven by a gas turbine, is now in dockyard hands at Barry, South Wales, where the turbine has been opened up for inspection after having operated at full power for 17,510 hr. The main problems encountered in running a marine gas turbine on boiler oil, as this one has been, are corrosion and fouling of the turbine blades.

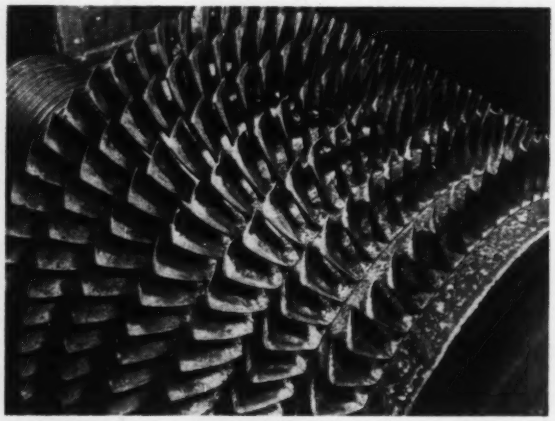
The installation in the *Auris* which is of 1200 hp, was constructed by the British Thomson-Houston Company and went into service in November, 1951. During the first three years it was necessary to operate for part of the time on diesel fuel, but with increasing experience it was found possible to run on the cheaper and more readily available boiler oil. The high-pressure part of the turbine was opened up in Lisbon a year ago and cleaned. Since then the turbine has consumed 500 tons of boiler oil, varying in viscosity from 1200 to 1500 sec Redwood No. 1 at 100 F. As the illustration shows, the rotor and blading were still remarkably clean.

In addition to the high-pressure turbine, the installation comprises an air compressor, heat exchanger, and a low-pressure turbine, but none of these required to be opened for cleaning. A certain amount of salt from sea spray is drawn into the compressor, but this can be removed by water injection; and soot accumulations on the heat-exchanger tubes are prevented by the use of steam jets. The rotor bearings and the thrust bearings were found to be in excellent condition and needed no attention.



High-pressure turbine rotor being lifted out of casing. This 1200-hp gas turbine was installed in the *Auris* in November, 1951.

The *Auris* was propelled originally by four diesel engines, one of which was removed when the experimental gas turbine was installed. The whole of this plant is now being taken out and will be replaced by a new British Thomson-Houston gas turbine of 5500 hp, which will drive the propeller through gearing. Like the earlier set, it will operate on boiler fuel, and is expected to show a fuel consumption comparable with that of a steam-turbine installation.



Close-up of rotor of the gas turbine of the oil tanker *Auris* as removed from casing. High-pressure row is in foreground.

Electronic Chess-Playing

An eye-catching demonstration of the possibilities of electronic control of machines was that of the Vaughan Crane Company, of West Gorton, Manchester 12, England, in conjunction with Heenan & Froude, Ltd., Worcester, England, who have been responsible for some of the most important electrical control systems on British automobile assembly lines, at the recent Mechanical Handling Exhibition in London.

The Vaughan Crane stand had its floor marked out as a chess board, on which were arranged wooden chessmen about 2 ft high, each with a steel plate on its top. The

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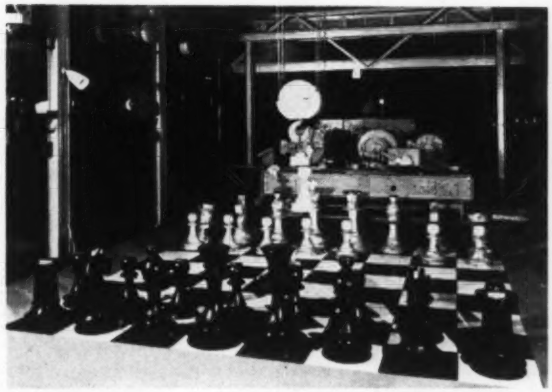
[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.



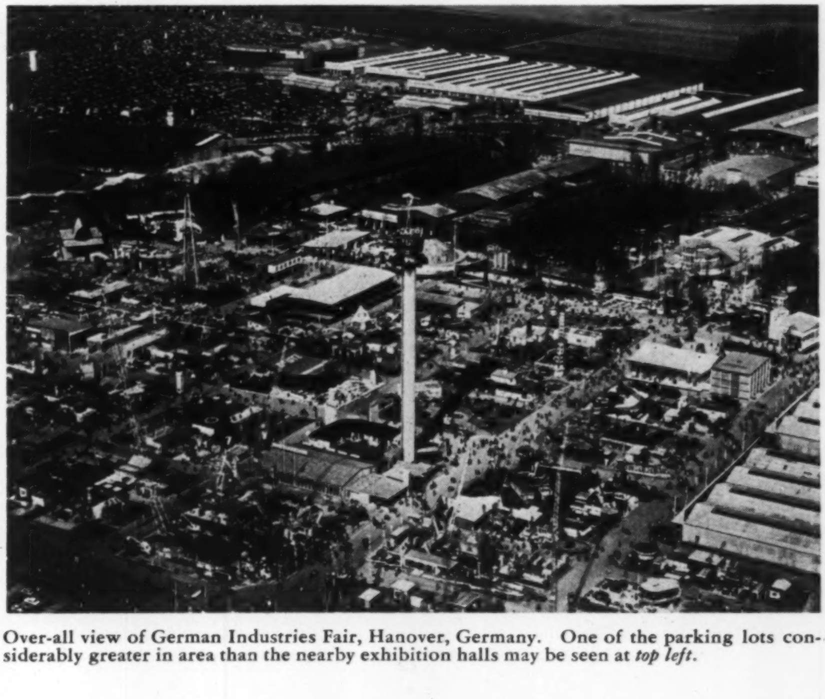
Vaughan overhead crane "playing chess" by electronic control

stand was spanned by an overhead electric crane with an electromagnet slung from its hook. Under the control of the Heenan & Froude unit, the crane automatically "played" a game of chess, picking up the pieces in turn with the magnet and placing them in accordance with the stored instructions.

The Hanover Fair

All over Europe, this is the season of fairs and exhibitions, which have now become so numerous that attendance at them has become somewhat of a burden to many industrialists, and still more so, perhaps, to the agents within the various countries of manufacturers whose plants are located outside of them. Nevertheless, the trend toward massed displays of goods is one that is unlikely to slacken, in spite of the agreements among certain categories of firms, through their trade associations, to take part only in certain selected exhibitions and, in some cases, at intervals of several years instead of annually. The value of a well-established and efficiently organized fair, however, is not to be measured solely by the aggregate of the orders booked; the education of the public is also an important function, even though its effect is practically impossible to assess, and it is particularly noteworthy that school children and students—the buyers of tomorrow—form a significant proportion of the public who flock (yes!—*flock*) to the principal exhibitions on the Continent of Europe.

A comparative newcomer among these European Fairs is that at Hanover, which, so far as West Germany is concerned (and, indeed, Western Europe as a whole), has more or less completely taken the place of the Leipzig Fair, now behind the Iron Curtain. The Leipzig Fair is still accessible, of course, to the trade visitor, who is the target of a considerable amount of annual persuasion to go there; but the Hanover Fair (officially described as the German Industries Fair) is now in its tenth year of rapid expansion and its position is not likely to be shaken. It was held this year from April 29 to May 8. How many people visited its 18 large halls and its 800,000 sq ft of open display space can only be guessed, for there are no turnstiles to check the numbers (practically everyone seemed to have some sort of a commuter's ticket or a pass), but the total must run well into seven figures. The parking lots must have received at least 20,000 automobiles even on a slack day (Sunday's total, anything from 50 to 100 per cent more) and that may be regarded as a reasonable gage of the effectiveness of West German recovery and of individual, as well as national, industry.



Over-all view of German Industries Fair, Hanover, Germany. One of the parking lots considerably greater in area than the nearby exhibition halls may be seen at *top left*.

Beyer-Garratt Steam locomotive for Mozambique, Hanover Fair 1956

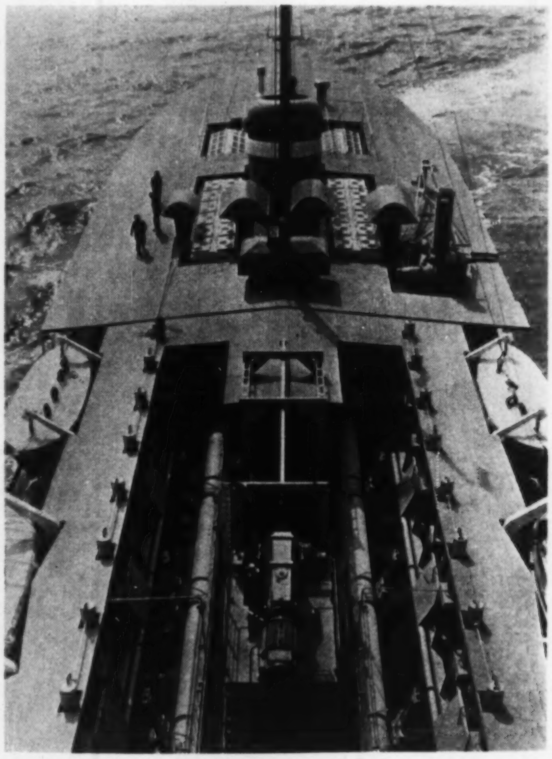
Garratt Locomotive for Mozambique

The steam locomotive may be dying, but not for lack of technical accomplishment, and one of the exhibits which attracted most attention at the Hanover Fair was a notable example of the species, a 4-8-2 + 2-8-4 Beyer-Garratt for the Mozambique Railway in Portuguese East Africa, built under licence from Beyer, Peacock & Company, Manchester, England, by the Henschel Maschinenbau G.m.b.H., Hamburg. Though of only 3-ft 6-in. gage, it weighs 194 tons in running order and has a tractive effort at 75 per cent of the boiler pressure (200 psi) of 61,000 lb. The cylinders are 19-in. bore, with a stroke of 24 in., and the driving wheels are 48 in. in diam. The total boiler heating surface on the fire side is 2625 sq ft, of which 2345.5 sq ft is tube surface. On the water side the heating surface is 2847 sq ft. The superheater has a heating surface of 873.75 sq ft, and the grate area is 61 sq ft. The total wheelbase is 81 ft $1^{1}/_{4}$ in., of which only 13 ft $1^{1}/_{2}$ in. is "fixed," so that it is possible to negotiate a curve with a minimum radius of 295 ft. The carrying wheels are $28^{1}/_{2}$ in. in diam. The length over the couplings is 91 ft 2 in. Henschel were also exhibiting Diesel locomotives, but there was no doubt that the Beyer-Garratt was the center of attraction.

Suction Dredger With Remote Control

One of the largest stands at the Hanover Fair was that of the group of German firms known as Orenstein-Koppel und Lübecker Maschinenbau A.G., makers of many types of heavy excavating plant, including the immense rotating-bucketwheel machines which are used to dig the great brown coal deposits. They also build, at Lübeck, all types of harbor and seagoing dredgers. This branch of their activities was represented at Hanover by models only, for obvious reasons, but they have completed recently a self-propelled trailing-suction dredger of 4820 tons gross for the Government of Indonesia, which will suck up 4250 tons of sand or mud in 40 minutes and is capable of a loaded speed of 10 knots. The vessel is 351 ft long over-all, 62 ft beam, and 26 ft deep, and is particularly notable for the complete remote-control equipment, by means of which the dredging master can lift and lower the suction pipe, control the pump, and open and close the discharge valves to the hoppers and also the dumping doors in the bottom of the 12 hopper compartments from the control room on the bridge.

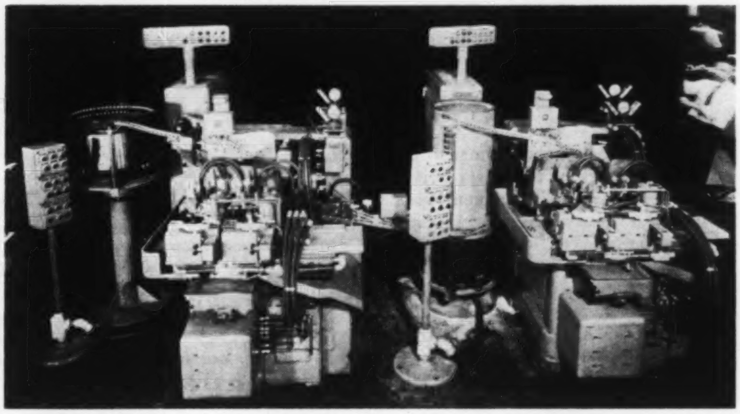
The power plant is diesel-electric, with three single-acting supercharged MAN diesel engines, giving 1350 hp each at 275 rpm, driving 850-kw 600-volt d-c generators. Each of the two four-bladed propellers is driven at 130 rpm, through reduction gearing, by a d-c motor with a maximum speed of 1000 rpm. Auxiliary diesel generator sets are provided for stand-by duties, harbor service, and emergency requirements. The dredging pump is driven at 350 rpm by a d-c motor of 2500 hp and will raise a mixture of sand or mud and water from a maximum depth of 15 meters (49 ft) below water level at the rate of 18,000 cu meters (23,500 cu yd) per hr. A 120-hp electric winch raises and lowers the suction pipe in the center well. The overflows from the hopper compartments discharge into this well. The pump delivery is divided between two for and aft pipes, $27^{1}/_{2}$-in. bore, at the height of the boat deck and hydraulically operated valves distribute the flow to the hoppers as the trim of the vessel may require. Dredging trials were carried out in the River Trave, between Lübeck and Travemunde, early in May—fetching up, it may be remarked, some particularly foul-smelling mud—and the vessel, which is named Sumatra II, left at the end of that month for the port of Djakarta, in Indonesia, where she will be stationed.



Suction Dredger "Sumatra II"—Deck view looking aft. The cylindrical projections coming through the top of the side awnings are the hydraulic cylinders which operate the bottom doors of the hoppers. On the central platform is the winch for raising and lowering the suction pipe.

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings



Bore-Matic pinion converter, featuring first fully automated machine tools with feedback in this country

Machine Design

Machine-Tool Automation and Feedback, by R. Ruszczak, The Heald Machine Company, Worcester, Mass. 1956 ASME Machine Design Conference paper No. **56—MD-3** (multilithographed; available to Feb. 1, 1957).

This paper describes the application of automation to a piston production line, to machine tools with feedback, and to a grinding machine with feedback. Steps are outlined that should lead to automation standardization in the near future and make automated machinery economical and flexible.

The automated machine tools with feedback semi-finish and finish-bore, face both sides, and chamfer pinion blanks on two spindles per machine, at a rate of 320 per hr at 80 per cent efficiency, with stock removal 0.010 on bore, 0.010 to 0.025 on faces to a tolerance ±0.0005 on bore, ±0.003 on thickness.

The pinions are conveyerized from previous operations to a hopper and then fed into a chute. Midway in the chute, prior to entering the machine, the pinions are stopped and air-gaged, qualifying the bore and thickness of part. This "Go-Nogo" gage insures the machine that the parts have been bored and faced properly in previous roughing operations. Any parts that gage off limits are dropped out of line through a trap door in the chute; "Go" parts continue to roll down into the chute on the machine.

At the top of the chute on the machine a probe unit controls the feed of the hopper. This probe unit cycles with each cycle of the machine and if the probe indicates that the chute is full of parts it will automatically stop the hopper. But if the probe indicates that there are no parts at the top of the chute, it will immediately start the hopper feeding parts to the machine. The probe unit is set up with a counter so that, if by chance the hopper is empty, it will probe a predetermined number of times before shutting down the machine and alarming a signal for the setup man to investigate the trouble.

After the parts pass the probing unit, the chute is constructed in such a manner that they are equally distributed between the two spindles. Here the parts are picked from the chute two at a time by a hydraulically operated loading mechanism and placed into diaphragm chucks, located, and clamped. Then the loading mechanism retracts back to its pick-up position and resets for the next cycle. The chucks start rotating, and the table makes a rapid approach to the work, which drops into a set freed for semi-finish bores. At the end of the bore stroke, the cross slide starts to generate the face and chamfer. The table next traverses fast to the starting position, and the parts are automatically ejected into two separate chutes located below the chucks and roll down the inclined chutes to independent gaging stations.

Here they are gaged, and if either one of the parts has reached a predetermined limit, feedback comes into play. The gage sends a signal back to the dial bar to make a corrective change plus or minus as the case may be. In this setup the dial bars are set to make ±0.0002 corrections with each cycle. Under or oversize parts are separated and dropped out of the chute into their proper receptacles for scrap or salvage.

If three consecutive off-tolerance parts are produced, the machine will automatically shut down and a red light on the panel will indicate which spindle is making off-tolerance parts. All parts that are within the tolerance by-pass the trap doors in the chute and move into a hopper that feeds them up to the second machine which finish-bores and generates the opposite face and chamfer. The sequence of operations and feedback on the second machine is identical to the machine as previously described.

Automation for Assembly, by R. G. Dexter, Mem. ASME, Barkley & Dexter, Inc., Fitchburg, Mass. 1956 ASME Machine Design Conference paper No. **56—MD-2** (multilithographed; available to Feb. 1, 1957).

This paper contains a brief discussion of automation in general followed by consideration of the problems of automation of assembly operations with emphasis on estimation of the cost of such developments. Two cost-estimating methods are outlined. Materials-handling problems connected with assembly automation are discussed and conclusions drawn as to the best approach to automation of assembly for the average manufacturer.

In general, the average manufacturer, when confronted by an assembly problem lending itself to possible automation, will obtain the best results by first appropriating sufficient money to obtain adequate preliminary designs and estimates indicating the scope of the development.

These preliminary studies will probably show that it will be most economical to handle the chassis or main body of the assembly on a flexible straight-line machine with quick-return fixtures. On such equipment it will be possible and often more economical to automate the simpler operations and leave at least one of the more difficult to be done by hand, paced by the straight-line machine. These operations may be made automatic later.

Ordinarily each part to be added to the assembly must be fed automatically from a conveyer, magazine, or hopper. For this purpose, many ingenious devices have been developed, as varied in design as the parts they feed. In general, they are classified as chain, slicer, rotary, oscillating, vibratory, vacuum, belt, and magnetic feeders, and they occur in every conceivable combination. Unless simple and symmetrical in design, manufactured parts to be assembled seldom lend themselves to feeding by commercially available standard feeders.

Devising the feeders for these parts is usually the most involved and expensive part of assembly automation. This development can be greatly simplified where consideration of the feeding problem is stressed in design of the parts themselves. Many times it is more economical to redesign components for feeding than it is to design feeders for existing components. Once the parts have been fed and oriented, their further control is likely to be comparatively easy.

The manufacturer will find it economical to avoid versatile equipment and to attempt maximum standardization of his product including redesign of components for easier automatic assembly. In cases where the assembly is not standard, he will often find that subassemblies of the whole are standard and can be automated successfully where the whole assembly cannot.

Most automated assembly lines require automatic inspection of various components or of the assembly. This may consist of electrical, electronic, or mechanical inspection for dimension or electrical characteristics and may require throwing out a defective part and holding back all of the mating parts.

The trend in automation is away from straight mechanism and toward more electrical control of operations. However, for the average manufacturer, an automated assembly line with any great degree of versatility is financially prohibitive. An automated line would ordinarily be considered only where there is a high degree of standardization of the product. In process industries, on the other hand, where various formulations of many different ingredients are required, a punched-tape system can be extremely profitable.

Oil and Gas Power

Experiences with Aluminum Bearings in Heavy-Duty Engines and Compressors. By J. P. Hyde, Mem. ASME, Ingersoll-Rand Company, Phillipsburg, N. J. 1956 ASME Oil and Gas Power Conference paper No. **56—OGP-3** (multilithographed; available to April 1, 1957).

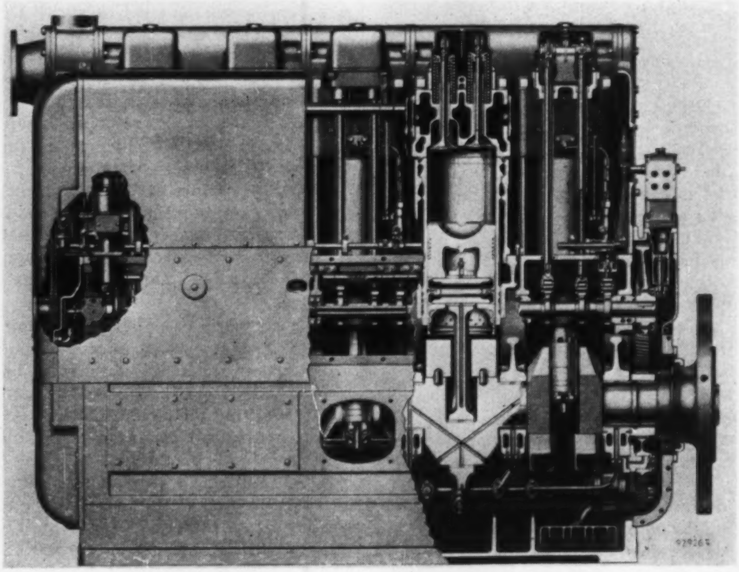
The use of aluminum bearings of both the full-floating and fixed types is described. Test data are given on the action of the full-floating bearing; i.e., its speed of rotation and its radial movement within its clearances. The discussion is confined to aluminum bearings applied to heavy-duty engines and compressors.

Aluminum was introduced as a material for bearings because experiments indicated that it might contribute to lower cost, longer life, and reduced maintenance expense of bearings. The use of aluminum instead of babbitt eliminates the process of bonding and machining the babbitt on the inside and outside surfaces. Several other applications of aluminum bearings in the author's company are described.

Experience over a period of more than ten years has proved to the author that aluminum is a superior bearing material for heavy-duty diesel engines, gas engines, and compressors. Bearings of both the fixed type and full-floating type have been used successfully. The direction of radial movement of the shaft and the sleeve in a full-floating bearing leads the direction of the load force as would be expected from the hydrodynamic theory of journal lubrication, even in a reciprocating machine. The speed of rotation of a floating-bearing sleeve is uniform and dependent upon the relative outside and inside clearances.

Rating Engines by Fuel-Air Ratio Effects, by Robert J. Cramer, Jr., Mem. ASME, and Kurt F. Froehlich, Mem. ASME, Nordberg Manufacturing Company, Milwaukee, Wis. 1956 ASME Oil and Gas Power Conference paper No. **56—OGP-8** (multilithographed; available to April 1, 1957).

The safe rating of an engine is dependent upon many factors, and many attempts have been made to find a rational basis for rating engines. With few exceptions engine designs are mechanically safe for speeds and maximum pressures far above the actual operating conditions. The limitations on ratings are chemical and thermal in nature, determined by formation of deposits and by the ability of the piston rings, cylinder liners, in-



Longitudinal section of 700-hp diesel engine showing full-floating aluminum main and crankpin bearings

jection equipment, and valves to withstand the stress and wear imposed by the combustion. The differential-thermal-efficiency method developed in this paper makes it possible to assign comparative ratings to engines of widely varying designs by means of a series of simple measurements of the fuel input and power output and to assess the effect of engine developments and improvements.

About six years ago the authors began a search for means of correlating the performance of a single cylinder, two-cycle engine with that of multicylinder production engines which would eliminate the effects of a different relative friction and of an externally powered scavenging air supply, different flow conditions, and resistance in the intake and exhaust piping. Brake thermal efficiency or apparent indicated thermal-efficiency curves were obtained by dividing output by input after plotting the relationship between the input and output in the same terms. It was noted early in this study that the slope of the characteristic line near the origin was nearly identical for all two-cycle engines investigated, and from this observation the concept of differential thermal efficiency developed. The slope of the characteristic line at each point represents a type of differential thermal efficiency—the difference in output caused by an increase or decrease in the quantity of fuel injected per stroke. It reflects the effect of all influences on the combustion process—fuel-air ratio, characteristics of the injection system, cooling, leakage, throttling, as well as mechanical friction. If the characteristic line is carried to the point where all available oxygen is used up, the characteristic line will become horizontal and the differential thermal efficiency line will fall to zero.

No engine can be rated at a point where the differential thermal efficiency is near zero because the exhaust will discharge dense black smoke. But the use of a differential thermal efficiency at some point higher than zero offers a convenient and valuable criterion of the relative performance of the same engine and of different engines. Although exhaust smoke is not a good criterion in itself, if the injection system of an engine is well designed, smoke will be absent at any value of differential thermal efficiency above 30 per cent.

The differential thermal efficiency is approximately related to the fuel-air ratio actually occurring during the combustion. This is in contrast to other methods which determine the fuel air in the cylinder, whether by measurement or calculation. The distinction is definite when the combustion process is incomplete because of lack of available air. The differential thermal efficiency, therefore, measures all factors necessary to establish a comparative rating for engines of widely different types.

A Combustion System for Spark-Fired Gas Engines Using Diesel Compression ratios, by L. D. Thompson, R. H. Beadle, and F. A. Blake, Fairbanks, Morse & Company, Beloit, Wis. 1956 ASME Oil and Gas Power Conference paper No. **56—OGP-6** (multilithographed; to be published in Trans. ASME; available to April 1, 1957).

The combustion system known as "jet ignition," which eliminates the requirement of air modulation with varying loads in a spark-fired gas engine, and the background leading to the development of this system are described in this paper.

The basic object of the spark-ignition program is to retain the thermal advantages inherent in high-compression gas engines while eliminating the liquid-fuel requirements. Experience has shown that while the quantity of liquid fuel for dual-fuel engines may be only 5 per cent of the full-load fuel the cost may be as high as 30 per cent of the total fuel bill.

The jet-ignition system functions during each engine cycle as follows: (1) It automatically obtains a readily ignitible charge in the auxiliary chamber; (2) the spark fires the localized auxiliary charge; and (3) the combustion which follows in the auxiliary chamber blasts a jet of flame through the orifice into the main chamber where the jet ignites the main charge.

Jet ignition coupled with diesel compression ratios results in a versatile engine having high thermal efficiency and simple controls. Engine governing with jet ignition only requires control of the fuel as in diesel engines.

The Measurement of Engine Response to Sudden Load Changes, by L. T. Brinson, Jr., Mem. ASME, and E. C. Schuster, Nordberg Manufacturing Company, Milwaukee, Wis. 1956 ASME Oil and Gas Power Conference paper No. **56—OGP-7** (multilithographed; available to April 1, 1957).

This paper presents a method of measuring characteristic engine response to sudden load changes. The rate at which an engine will respond to a new load demand is developed by a comparison of the energy made available to the engine versus the total output as measured by the torque equivalent of friction, load, and acceleration for one revolution. This output under transient conditions is then compared with the steady-state characteristics which can be expressed as a transient-response efficiency for any given heat input.

The advent of supercharging, higher engine speeds, and operation on fuels requiring close control of air-fuel ratios has materially increased the importance of determining engine transient performance characteristics. Many applications such as natural-gas pipe lines, oil pipe lines, electric generating plants, locomotive, marine, and dragline operations have definite requirements for engine response with sudden varying loads. Some systems require immediate response, while in others a certain lag acting as a cushioning effect is desirable.

Factors that will influence the steady-state output of an engine are: amount of fuel available to the engine cylinder; amount of air available to the engine cylinder; mixture ratio of fuel and air in the engine cylinder; engine speed; combustion efficiency; and thermal efficiency of the cycle as established by compression ratio, expansion ratio, duration of burning and modified by heat transfer, friction, turbulence, etc. Factors that will influence the transient response of an engine are: time required to supply more fuel to the cycle; time required to supply more air to the cylinder; degree of mixture ratio attained compared to the steady-state condition; amount of speed variation; governor response; and engine inertia.

Transient-response efficiency permits direct comparison of the transient response of various sizes and types of engines. In addition, it allows prediction of the response of engine, turbocharger, manifold, governor, and flywheel system. The test results so far obtained demonstrate that the relatively simple instrumentation records the information necessary to establish the transient performance of any engine. Simulating load changes by rapid manipulation of the governor load-limit adjustment approximated a load-step function. This presentation of transient performance data has proven useful in evaluating various engine-load combinations.

Maintenance Practices in a Large Internal-Combustion Power Plant, by H. Keefer, Aluminum Company of America, Point Comfort, Texas. 1956 ASME Oil and Gas Power Conference paper No. **56—OGP-5** (multilithographed; available to April 1, 1957).

How to provide lowest possible maintenance cost with high unit availability in an installation involving 220 power-generating units, supplying an extremely critical process with a 95–98 per cent load factor and no outside utility connection 24 hr per day, 365 days per yr, is the problem discussed in this paper. Considerable success has been achieved towards this goal during the past six years of operation at the power-generating plant of the author's company by the application of the following basic principles: (1) a strict schedule of planned preventive maintenance on all equipment; (2) close co-ordination between the operating and maintenance personnel; and (3) appreciation of the importance of maintenance in all designs, with every effort made to provide a simple installation.

The present program is based on scheduled outages at definite time intervals and is divided into two phases: (1) a routine scheduled outage for minor maintenance and control-equipment check, and (2) a scheduled outage for major maintenance and overhaul.

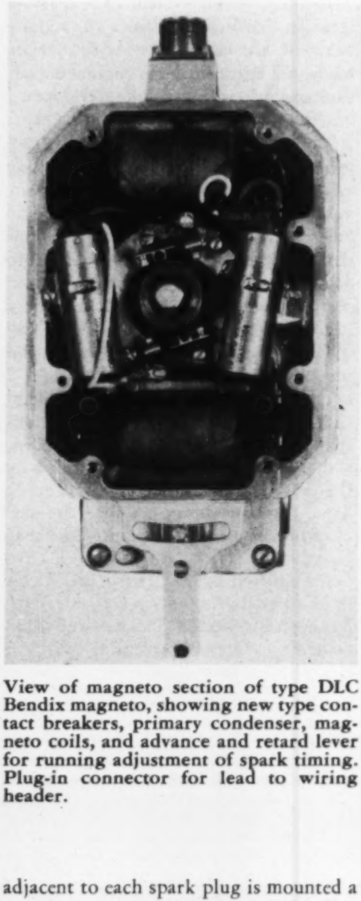
The first phase is set up for an electrical generator and switchgear inspection every 4 months and a mechanical engine inspection every 12 months. A one-shift outage per unit is involved in the electrical check, and a two-shift outage per unit is involved in the mechanical check. This work is progressively scheduled so that the workmen move from one unit to the adjacent unit.

The routine for the electrical inspection requires the following: Blow and wipe generators; check and replace brushes as required; check operation of engine and generator shutdown devices; clean and check switchgear; clean building air washing sumps; check oil sump tank baskets. The mechanical inspection calls for these checks: Change spark plugs; check distributor points; check spark-plug resistors; clean carbon from exhaust ports; replace cylinder-head water hoses; overhaul governor; replace gaskets as required; check engine overspeed; check entire ignition system using cathode-ray setup.

The second phase of the maintenance program, which involves the disassembly of the engine or generator, is based on years of operation. At five-year intervals, this program is followed: (1) engine down for one-week period and unit disassembled; (2) engine generator exterior painted; and (3) heat exchanger and associated piping checked for corrosion and deposits. At five to ten-year intervals, this program is covered: (1) generator armature and field cleaned and reinsulated; (2) commutator ground; (3) commutator under cut; (4) auxiliary motors cleaned and reinsulated; and (5) auxiliary motor bearings cleaned, inspected, and repacked.

Recent Developments in Gas-Engine Ignition, by R. B. Clark, Mem. ASME, Bendix Aviation Corporation, Sidney, N. Y. 1956 ASME Oil and Gas Power Conference paper No. **56—OGP-4** (multilithographed; available to April 1, 1957).

This paper reviews developments in the low-tension ignition system and discusses, in particular, a new low-tension magneto for gas engines. The low-tension ignition system consists of a magneto producing voltage in the neighborhood of 300 to 500 volts which is distributed through low-tension wiring to the cylinders on the engine. On each cylinder and adjacent to each spark plug is mounted a transformer coil which changes this low voltage to one high enough to break down the spark-plug gap.



View of magneto section of type DLC Bendix magneto, showing new type contact breakers, primary condenser, magneto coils, and advance and retard lever for running adjustment of spark timing. Plug-in connector for lead to wiring header.

The experience gathered through the years with low-tension magnetos together with the materials and techniques developed during and after the war years have been applied to the design and construction of a completely new low-tension magneto for gas engines. This unit makes it possible to obtain all of the advantages of a low-tension ignition system and at the same time fulfill newer requirements. The voltage available to fire spark plugs has been nearly doubled. Completely new contact breakers for the magneto have been designed and developed, and a new distributor contactor similar to the main breaker has been developed. These units not only reduce the maintenance problem almost to the vanishing point for service periods exceeding 12 months, but at the same time insure more accurate timing of the ignition spark.

Low-tension magnetos are now available for engines having as many as 16 cylinders whereas before the largest unit made was for a 6-cylinder engine. This meant that on units having more than 6 cylinders it was necessary to double up on magnetos or use battery ignition, but here again the limitation was 8 cylinders. The elimination of the need for maintenance between long engine-overhaul periods was the goal when designing this new magneto. However, serious consideration was given to the idea of making any necessary maintenance operations as simply performed as possible. All adjusting screws are readily accessible and the necessity for hand adjustments or shimming of parts when replaced has been eliminated.

In the author's opinion a low-tension magneto ignition system which will perform with the utmost satisfaction for long periods of time is now available and, since it is a low-tension system, all of the benefits to be derived from such a system are available for the operators of gas engines. These are freedom from troubles encountered with high voltages such as flashover, acids, humidity, condensation, corona, insulation breakdown, electrical leakage and energy loss due to secondary capacitance. In addition the system will fire spark plugs having low leakage resistance caused by conductive surface deposits. It also reduces spark-plug erosion. This new unit has been on the market only a very short time but is already receiving wide acceptance among operators of gas engines.

The Performance of Controllable-Pitch Propellers in River Towboat Operation, by Captain R. F. Clark, Lake Tankers Corporation, Hartford, Ill. 1956 ASME Oil and Gas Power Conference paper No. **56—OGP-2** (multilithographed; available to April 1, 1957).

This paper discusses the advantages and disadvantages of controllable-pitch propellers in general and some of the experiences of the author's company in designing and operating a towboat on the

Mississippi River which was fitted with controllable-pitch propellers. High initial cost is emphasized as the primary disadvantage of these propellers, but the author believes that this cost is more than offset by the advantages.

For the general classification of work boats (including river boats, harbor tugboats, and various ocean-going vessels such as fishing boats, rescue ships, buoy tenders, etc.) the author gives as the primary advantage of controllable-pitch units their ability to adjust pitch to suit the various towing loads encountered in their normal operations. These conditions may vary from the static or zero speed pull required of a harbor tug in docking a ship, to maximum free-running speed of a rescue tug running to pick up its tow. When these vessels are fitted with fixed-pitch propellers, the propellers must be designed on the basis of a compromise between optimum pitch for free running and optimum for maximum ahead pull. Therefore, fixed-pitch vessels are seldom if ever operating at optimum efficiency.

Another advantage of controllable-pitch propellers is providing unidirectional operation of the engine or turbine, thus avoiding the high physical and thermal stresses inherent with a directly reversing machine installation. Furthermore, the unidirectional feature lends itself to burning lower-cost fuels if suitable engines are chosen, thus resulting in a substantial saving in fuel expense.

Other advantages of controllable-pitch units tend to show up in special vessels such as double-ended ferryboats, where a single engine can have its shaft extended in both directions and with controllable-pitch units on each end co-ordinating pitch settings so as to provide the optimum push-pull propeller efficiency. An economical fire-boat design results from using an engine for both pumping and propulsion—the pitch being co-ordinated with pump load so that the vessel can maneuver and pump simultaneously if necessary.

The one disadvantage inherent in all controllable-pitch propellers on the market today is high first cost. These propellers run two to three times the cost of conventional propeller and shafting on a reversing-drive boat; i.e., the total cost of a good fixed-pitch propeller, plus solid shafting, plus reversing feature on engine or gear, plus pilothouse controls appears to run between one third and one half of the cost of a controllable-pitch installation. However, the author believes that, with a conservative evaluation of the advantages involved, in his company the additional cost of this type of installation has been recovered in less than two years of operation and has, therefore, been a very good investment.

Heavy Fuel and Cylinder Wear in Marine Diesel Engines, by J. M. A. Van der Horst, Mem. ASME, Van der Horst Corporation of America, Olean, N. Y. 1956 ASME Oil and Gas Power Conference paper No. **56—OGP-1** (multilithographed; available to April 1, 1957).

This paper considers the factors contributing to increased liner wear resulting from the use of heavy fuel in marine diesel engines. Investigation of these factors is called for by reports from companies which indicate that the rate of cylinder wear is markedly increased by the use of heavy fuel; these companies have experimented with heavy fuel, often to avoid the high cost of diesel fuel, and find that most engines operate on heavy fuel without trouble after minor modifications are made to fuel-purifying and heating equipment.

The factors discussed which may contribute to the increased rate of cylinder wear are these: Viscosity and gravity, abrasion, corrosion, and cylinder-wall materials. No correlation is found between viscosities and the rate of wear, and the paper points out that neither viscosity nor gravity has ever been found to have a direct influence on cylinder wear.

Attempts to correlate ash content and cylinder wear often show very inconclusive results; however, there is little doubt that heavy fuel has to be centrifuged or filtered in order to remove, among other things, insoluble ash. This insoluble ash, consisting of earthy particles, rust, etc., would, if passed on to the engine, cause fuel pump and injectors to fail on short notice, and also would cause severe wear in the cylinder liners. The discussion indicates that only a fraction of total ash content of the fuel may actually be removed by centrifuging.

Corrosion has generally been viewed as the factor primarily contributing to the increase of the rate of cylinder wear in ships operating on heavy fuel. Particularly, corrosion by sulphuric acid, formed by the combustion process from sulphur in the fuel, is mentioned. As evidence of this corroding influence, it is cited that the highest sulphate percentages are always found in material adhering immediately to the metal of the cylinder wall. Some reports seem to contradict the influence of sulphur on wear, but in those cases the influence of other variables such as cylinder temperature and vanadium pentoxide was generally ignored. To combat corrosion and to keep piston and cylinder clean, the author recommends the use of fuel additives and special lubricants, and he suggests that the quantity of lubricating oil injected before stopping and after starting the engine be increased greatly.

The selection of a cylinder-wall material which is less subject to corrosive and abrasive attack is also recommended as an important factor in reducing the rate of cylinder wear. An effective method of overcoming the wearing effect of heavy fuel is to plate the cylinders with porous chromium. It is generally recognized that chrome plating reduces cylinder wear considerably.

Instruments & Regulators

Representation of Nonlinear Functions of Two Input Variables on Analog Equipment, by D. A. Elliott, Curtiss-Wright Corporation, Caldwell, N. J. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-11** (multilithographed; to be published in Trans. ASME; available to Jan. 1, 1957).

A method is described which uses standard analog components without any modifications to accomplish the simulation of three-dimensional functions. A graphical method of matching the desired family of curves is used to determine the necessary analog relations. This provides a simple method having reasonably good accuracy, which is readily adaptable to a large variety of functions. Although the method depends upon a somewhat regular progression among the lines in a family of curves, most functions do have such a progression. With this method it is possible to match all curves which are encountered in the simulation of several types of ramjet and turbojet engines with sufficient accuracy to achieve the aim of analog computation; i.e., the study of dynamic-stability characteristics in control-analysis problems. For such studies, the principal requirement is that the correct slopes, or partial derivatives, be present to relate the variables at any particular operating point.

Function-generating equipment that will develop nonlinear functions of a single input variable are now available for many types of analog equipment, but equipment that will directly generate three-dimensional families of curves as arbitrary nonlinear functions of two input variables exists only in a few cases of highly expensive specialized equipment. Since only standard analog equipment is used, the circuits may be drawn in a normal manner once the constants have been determined. Interconnections among analog components can be made easily from the circuit diagrams by anyone familiar with analog connections, since no special revisions to components are required. By using all electronic-function generators and multipliers, no objectionable dynamics are added to the problem.

Extension of these methods to functions of three input variables is also possible. If such a function can be plotted as a series of families of curves, the transitions between families can be determined. Suitable shifts can then be applied in much the same manner as used to convert functions of a single variable to functions of two. Obviously the amount of equipment required and the complexity of the problem increase when an additional input variable is introduced.

How to Obtain Describing Functions for Nonlinear Feedback Systems, by Karl Klotter, Mem. ASME, Stanford University, Stanford, Calif. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-5** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).

A METHOD is presented by which describing functions for nonlinear elements, whose behavior is defined by nonlinear differential equations (as contrasted with nonlinear relationships between the input and output variables themselves), can be obtained immediately (without first solving the differential equations).

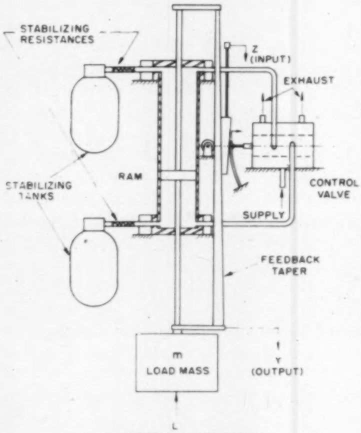
The author accepts the concept of the describing function as customarily used and applied, in the following terms: In a nonlinear element a sinusoidal input will produce a nonsinusoidal, although (for steady state) periodic, output. In order to perpetuate the use of a (complex) amplitude ratio one may work with the first harmonic of the periodic output. He applies his method to feedback systems containing one linear and one nonlinear element each described by a second-order differential equation.

Nonlinear Integral Compensation of a Velocity-Lag Servomechanism With Backlash, by C. N. Shen, Dartmouth College, Hanover, N. H., and H. A. Miller and N. B. Nichols, Mem. ASME, Raytheon Manufacturing Company, Waltham, Mass. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-3** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).

WHEN backlash is encountered in a velocity-lag servomechanism, the system may become unstable. The loop-gain limitation imposed is becoming unacceptable with increasing requirements for following steep ramp inputs as in certain machine-tool control applications. Integral compensation is not applicable since, with backlash, oscillations result. This paper analyzes an attempt to overcome this difficulty by intentionally incorporating a second nonlinearity, a dead zone in the input to the integrator. Results are given which allow the approximate transient response of certain systems to be obtained quickly, and the question of stability is considered. Finally, an example of its application is given along with a discussion of several practical factors involved.

The system may prove advantageous in certain circumstances with relatively large values of backlash and where it is necessary to follow a ramp input. The steady-state following error is reduced but an offset is introduced. Means are indicated which may reduce this impairment. With this method the steady-state system error is no more than half the backlash for step and ramp reference inputs.

Nonlinear Analog Study of a High-Pressure Pneumatic Servomechanism, by J. L. Shearer, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1956 ASME Instruments and Regulators Division Conference paper No. **56—IRD-1** (in type; to be published in Trans. ASME; available to Jan. 1, 1957).



Schematic diagram of pneumatic positioning servomechanism

A DETAILED analog simulation was made in order to evaluate the effects of nonlinear valve characteristics, nonlinear ram-chamber compliance, and coulomb friction in the ram on the dynamic performance of a high-pressure pneumatic servomechanism that had been studied previously with a linearized analysis. This analog study revealed that a major part of the discrepancy between measured frequency-response characteristics and the frequency-response characteristics computed from a linearized analysis is caused by coulomb friction in the ram.

Although the system is decidedly unsymmetrical when the ram moves near one end of its cylinder, the over-all dynamic characteristics are nearly the same as when the ram moves near its center position. Thus a simple linearized analysis of ram-chamber characteristics, which is possible only when the ram is near its center position, is applicable throughout most of the operating range of the ram. The nonlinear characteristics of the control valve did not seem to be significant in the problem because large pressure differences across the ram never were required to drive the mass load.

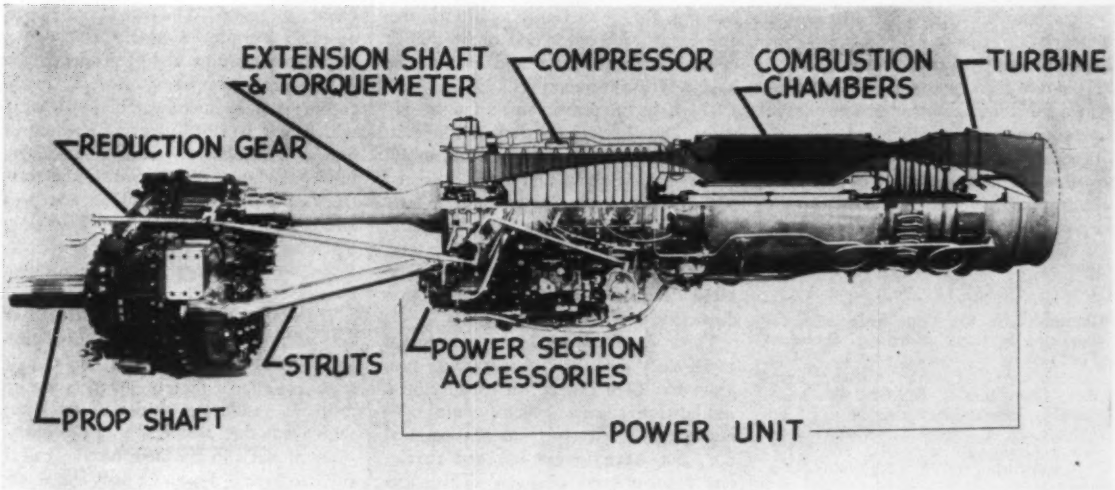
Gas Turbine Power

Development of the Allison Turboprop Engine, by G. E. Holbrook, Mem. ASME, General Motors Corporation, Indianapolis, Ind. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-17** (multilithographed; available to Feb. 1, 1957).

A MODERN turboprop power plant, developed under Government sponsorship, has been adopted by commercial airline operators as offering advantages in power, weight reduction, size, economy, and noise reduction over presently used equipment. This power plant is described, together with several measures which are required to assure safe, economical operation in airline service.

The first American-made turboprop airliner to be announced is the Electra, powered by four Allison 501-D13 engines and Aeroproducts propellers, and designed and manufactured by the Lockheed Aircraft Corporation. It is expected to be in service carrying ticketed passengers in the fall of 1958.

The Electra will be about midway between the size of a DC-6 and a DC-7, but will be substantially faster than either one. It is intended primarily as a short and medium-range transport for carrying passengers and cargo for trip lengths of 50 to 2100 miles. The relatively large power available from the turboprops gives it take-off, climb, and landing characteristics which will permit it to operate from landing fields now served only by smaller aircraft. The power loading will be 7.3 lb gross wt per rated take-off equivalent hp as compared with 9.4 to 10.7 for existing commercial aircraft.



Allison 501-D13 power-producing gas-turbine engine for use on the Electra, first American-made turboprop airliner

The complete turboprop power plant is considered to consist of two basic elements: (1) power-producing gas-turbine engine delving mechanical power to (2) a thrust-producing propeller. The gas-turbine engine portion of the power plant is divided into three distinct sections: the reduction gear, the interconnecting structure including torquemeter and struts, and the power unit. The general configuration of the separated reduction gear and power unit, as contrasted with that in which the reduction gear is mounted within the power unit inlet annulus, affords the aircraft manufacturer enough length between the propeller and the compressor inlet to design an efficient inlet duct and a resulting high ram recovery.

The power-unit assembly consists of a fourteen-stage axial flow compressor, a cannular combustion section, having six combustion chambers, and a four-stage turbine. The entire unit is of alloy steel or stainless steel except for the air intake housing and engine accessory drive housing, which are of magnesium alloy.

The compressor delivers approximately 32 lb per sec of air at a pressure ratio of approximately 9.3:1 at sea level. The combustion section consists of a one-piece outer tube, an inner tube forming a low-pressure oil sump area between the compressor and turbine, and the six combustion chambers. The turbine stator consists of a series of fabricated casings supporting the vane segments. The turbine rotor consists of four wheels and three intermediate spacers splined on a central shaft and clamped together tightly at the hub.

The Aeroproducts Model A6441FN-606 propeller matched to the Allison 501-D13 engine has four hollow steel blades, is 13 ft 6 in. in diam, and includes an aluminum spinner which serves to cowl in the regulator and electrical de-icing boots on the inner portions of the blades. The propeller regulator mounts on and rotates with the rear of the hub and contains the necessary mechanism and hydraulic oil to provide controlled flow to the torque units. The hydraulic system is completely self-contained. Hydraulic power to operate the blade torque units is obtained from four gear pumps, driven by a stationary reference gear, and an electrically driven feathering pump used to complete the feathering cycle when propeller rotation is too slow to produce the necessary flow from the gear pumps in the regulator.

An Experimental Arrangement for the Measurement of the Pressure Distribution on High-Speed Rotating Blade Rows, by K. Leist, Technical University, Aachen, Germany. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-13** (multilithographed; to be published in Trans. ASME; available to Feb. 1, 1957).

For several years past, the research staff of the Institute for Turbomachines of the Aachen Technical University has carried out measurements on rotating turbine blading. This program is part of a comprehensive effort directed toward the experimental investigation of the three-dimensional flow through axial-flow turbomachines.

Measurements on rotating blades are considered of interest because the effect of rotation of the row, and of the centrifugal forces arriving therefrom, upon the flow of the working medium so far have been explored but slightly. The author does not attempt to determine this very complicated flow precisely in its entirety. However, he gathers a maximum of significant information from measurements on coaxial cylindrical sections. This information may not be adequate as a basis for the establishment of a generally valid method of analytical treatment of the flow because of the elusive nature of the mutual influence of numerous contributing influences. Nevertheless, the results of such measurements should be an important contribution to the three-dimensional theory of axial-flow turbomachines.

Effect of Ambient and Fuel Pressure on Nozzle Spray Angle, by S. M. De Corso and G. A. Kemeny, Westinghouse Electric Corporation, E. Pittsburgh, Pa. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-3** (in type; to be published in Trans. ASME; available to Feb. 1, 1957).

Diametral samples across the fuel spray at a distance of $4^1/_2$ in. from the nozzle tip were obtained for ten centrifugal-type nozzles of 9 to 100-gph capacity, having nominal spray angles of 45 and 80 deg. The data were taken over a fuel-pressure range of 25 to 400 psi and for ambient pressures from 0.1 to 8 atm. These diametral spray distributions were reduced to equivalent spray-angle values which when plotted against ambient and fuel pressure provided a summary of the pressure effects on the spray angle. It was found that the spray angle decreased markedly with increasing fuel and ambient pressure. An explanation of the phenomenon is given. The equivalent spray angle was found to be a function of the product of fuel-pressure drop and ambient gas density to the 1.6 power, i.e., $P\gamma^{1.6}$.

Increased Life for Gas-Turbine Combustion Systems Burning Residual Fuel, by R. W. Macaulay, Assoc. Mem. ASME, General Electric Company, Evendale, Ohio, and C. M. Gardiner, Mem. ASME, General Electric Company, Schenectady, N. Y. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-1f** (multilithographed; available to Feb. 1, 1957).

This paper describes a new type of liner and fuel nozzle which, on the basis of limited field experience, have shown considerable improvement over the combustion liners and nozzles originally used in General Electric gas turbines. The paper also gives a brief review of test data and operating experience on combustion liners and fuel nozzles.

The combustion system originally used on General Electric gas turbines employed a cap and four overlapping liner sections with annular gaps at each overlap to admit cooling air along the following section. This cap and liner, with a pintle-vortex nozzle, has been used as standard equipment on all General Electric locomotive gas turbines up to the present time. Operating experience, however, has shown that in this service, burning No. 6 fuel oil, and with frequent starts and stops and rapid change of load, both the liner and fuel nozzle have certain shortcomings.

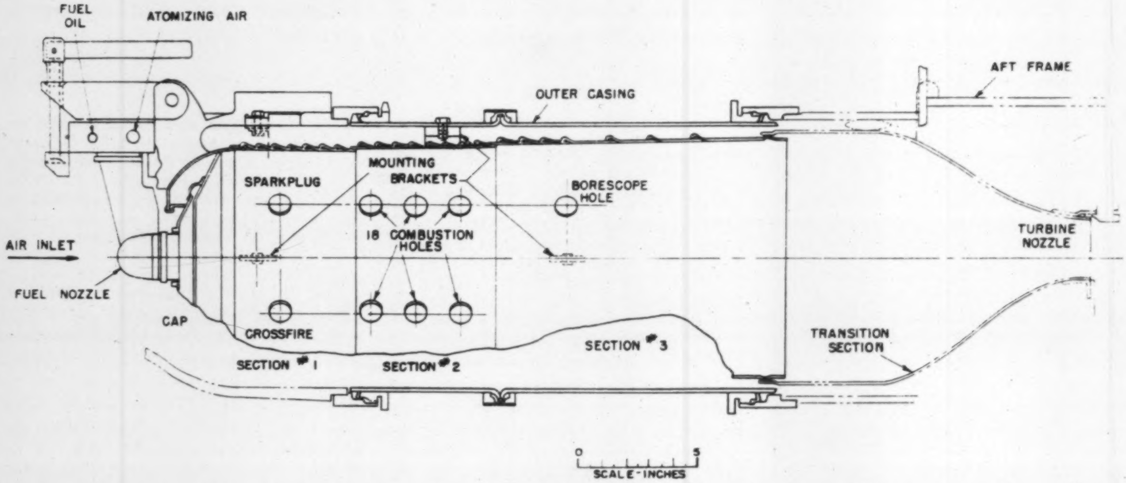
The liner life proved to be undesirably short, and the fuel nozzle was found to require frequent cleaning and reassembly. Damage to the cap and liner consisted of the burning away of louver tabs, or liner "hooks" in local areas, and warping, which then led to further overheating, closing off of cooling air slots, and rapid deterioration of the next section downstream.

These disadvantages were recognized at an early date, and a continuing program has been carried on to develop a combustion system which would burn bunker C as effectively as the original one, but have longer life and require less frequent nozzle changes. This paper reports the progress which has been made to date. Briefly this includes development of a thin-walled, punched-louver liner, similar to those used in many aircraft gas turbines, but suited to this application, and development of a new fuel nozzle.

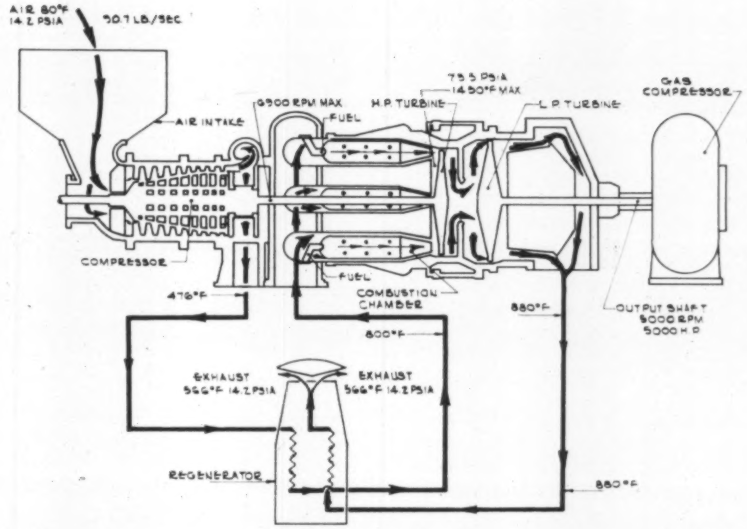
In cooling the hook liner it is necessary to use a small number of relatively wide annular slots, in order to minimize the effects of manufacturing variations and thermal distortion on slot dimensions. As a result the sheathing air must travel a considerable distance between slots, and it may not always provide adequate cooling on the downstream edge of the section over which it sweeps. In the louvered liner this situation is improved by admitting air through a large number of closely spaced openings, formed by punching small portions of the liner surface outward. The use of many such openings permits a nearly continuous thin sheathing film, and by proper choice of louver size, spacing, and location, cooling can be increased in local areas which tend to run hot and decreased in regions which run cool. Since the louvers are small, well cooled, and relative to their size quite rigid, they are less affected by thermal distortion than slots in the hook liner and are able to perform effectively for longer periods of time.

The pintle-vortex nozzle utilized a spin chamber into which the fuel was introduced through rather small passages, at approximately 300-psi pressure drop, to produce a thin uniform sheet which was then atomized by a concentric blast of air. In the new nozzle, called the "air swirl" type, not only the atomizing but also the initial spreading of the oil is done by air. In this nozzle, fuel is supplied through rather large passages into a central chamber where it is picked up by the spinning "primary swirl air" and fed uniformly across a narrow slot near the exit, through which a high-energy blast of spinning "secondary swirl air" is admitted. This atomizes the fuel and forms a relatively narrow spray, having approximately a 60-deg included angle.

Work is continuing in an attempt to improve these combustion systems still further, particularly in regard to smoke. In the meantime, based on the data and experience reported here, the crescent louvered liner with air-swirl nozzle and swirl-louver type of cap has been selected to replace the hook liner as regular equipment in oil-burning locomotive turbines.



Cross-sectional view of General Electric Company's locomotive gas-turbine combustion chamber with louvered liner and air-swirl nozzle



Schematic of 5000-hp regenerative-cycle gas turbine 1000 ft above sea level

El Paso's Gas-Turbine Operating Experience, by A. H. Carameros, El Paso Natural Gas Company, El Paso, Texas. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-6** (multilithographed; available to Feb. 1, 1957).

A SUMMARY of El Paso Natural Gas Company's operating experience covering design and operating problems encountered with 28 gas turbines from September, 1952, to January, 1956, is presented. Some discussion on operating and maintenance costs is also offered.

During September, 1952, the first gas turbine was put into operation on El Paso Natural Gas Company's Southern Division transmission system. Its purpose was to drive a centrifugal compressor which would pump about 1.1 billion cu ft per day over a ratio of 1.13, at about 600 psia suction pressure. The gas compressor needed, as a drive, a prime mover rated at 5000 hp at 80 F ambient and 1000 ft altitude.

The two-shaft regenerative-cycle gas turbine is coupled to the gas compressor by a floating flexible coupling, 42 in. long. Air is brought into the axial-flow compressor through an air washer which cleans and cools it. The axial-flow compressor then compresses about 90 lb per sec of air through 14 stages and discharges into the regenerator at 74 psia and 476 F.

The compressed air is then preheated in the regenerator to about 800 F, and fed into six combustion chambers where its temperature is raised to 1450 F by burning natural gas. About two thirds of the available power in the gas is absorbed by the HP turbine which drives the axial-flow compressor at 6900 rpm. About 5000 hp is absorbed by the load turbine at speeds varying from 4000 to 5500 rpm, depending upon the gas conditions in the centrifugal compressor. The exhaust gases then feed to the regenerator at 880 F where a heat exchange occurs with the compressed air. The stack temperature is 566 F.

The gas turbine is started by a small expansion turbine which uses 150 psi gas as a working fluid. The expansion turbine is coupled to the axial-flow compressor by a clutch through a gear box. The gear box allows power take-off during running to drive an auxiliary a-c generator and the turbine auxiliaries such as lube-oil pump and hydraulic controls.

The starting is accomplished automatically by proper timing and sequence. All of the control in the station is push button and usually requires no physical effort on the part of the operator.

The cost of operation of the gas-turbine stations has compared favorably with the company's reciprocating stations. Based on horsepower installed, the gas turbine is about 10 per cent cheaper to operate. Based on horsepower developed, the gas turbine is about 30 per cent cheaper to operate. The latter reflects load factor considerably, but when comparing stations of like load factor, this still holds true.

Design Considerations for Naval Gas Turbines, by G. L. Graves, Jr., Assoc. Mem. ASME, Bureau of Ships, Department of the Navy, Washington, D. C. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-1** (multilithographed; available to Feb. 1, 1957).

THIS paper discusses design considerations for a naval gas turbine in terms of duty-profile operating requirements and the basic parameters of engine design.

In considering duty-profile requirements for naval-combatant vessels, the main advantage of the gas turbine as in the case of emergency and booster engines is its low specific weight. It remains to be determined how much of this weight-saving can be used for increased fuel tankage or other equipments.

The maintenance advantages of a combatant naval gas turbine are rather difficult to evaluate at this time. Reliability and maintenance are related; however, it is possible to design for good maintenance with long periods between overhauls and yet not have good reliability. Reliability might be defined as inversely proportional to the number of forced outages. Maintenance might be defined as proportional to forced-outage costs plus overhaul costs.

Good reliability is dependent on having a minimum number of engine accessories and components in series; therefore simplicity of design is desirable. Items like intercoolers and other accessories have to be weighed in terms of complexity added to the engine versus performance gains.

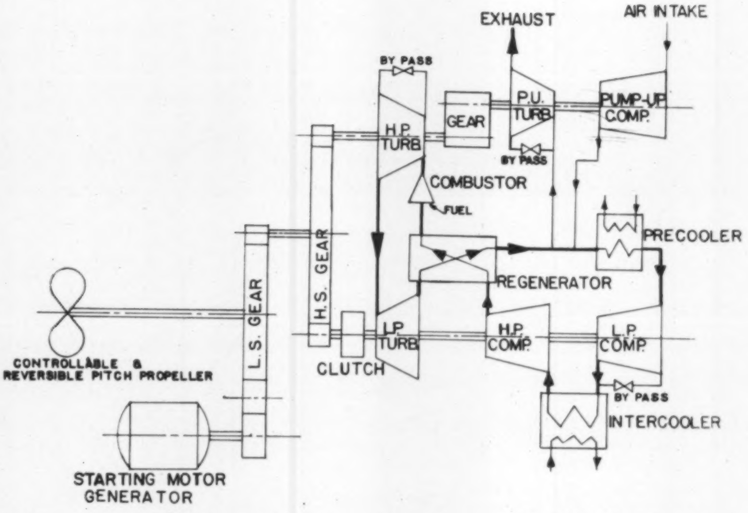
Reliability within the design overhaul life of the engine is the important consideration. The over-all reliability of an engine is only as good as the product of reliability factors for engine components and accessories in series. Components and accessories should be kept to the minimum necessary for push-button operation with good part-load fuel consumption.

The reliability of components for a given overhaul life is something that cannot be compromised. Neither can the operating characteristic requirements be compromised below a certain minimum. For those applications where part-load performance is important, it is necessary to have good part-load component efficiencies. To achieve producibility and good mechanical reliability, aerodynamic and thermodynamic compromises are necessary. Both compressor and turbine-component efficiencies are important; however, the turbine-component efficiency is relatively more important than compressor efficiency and therefore leaves very little room for compromise.

Good maintenance is dependent on the

concept of excellent reliability within the operating overhaul period, as well as designing for rapid disassembly and replacement of complete component sections (such as turbine rotors). Down time can be kept to a minimum, resulting in increased availability of the ship and decreased maintenance-personnel requirements. By replacing complete sections and shipping small sections to a repair base for overhaul, the level of training of ship's service personnel will be a bare minimum. Small sections could be stored on board and periodically deposited at a repair base. Auxiliary engines designed for 1000 hr between overhauls would require more overhauls than other engines; however, the ease of overhaul, small size of parts, and the small number of parts subject to failure should make up for this. It is believed possible to obtain better than 1000 hr at full power between overhauls at some time in the future.

The duty profile or required operating characteristics determine the thermodynamic regimes for which a power plant is designed. The compromises in compressor efficiency to obtain pressure ratio or the compromises in turbine efficiency to obtain higher turbine-inlet temperatures are dependent on the duty profile and thermodynamic considerations. On paper, gas-turbine engines look as if they can be designed for maximum simplicity and reliability. The proof of the paper studies can only be determined by obtaining fleet operating experience.



Schematic diagram of internally fired, semi-closed gas-turbine plant for naval propulsion

Internally Fired, Semi-Closed-Cycle Gas-Turbine Plant for Naval Propulsion,

by S. H. DeWitt and W. B. Boyum, Assoc. Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-16** (multilithographed; available to Feb. 1, 1957).

This paper describes an internally fired, semi-closed-cycle gas-turbine plant built for the U. S. Navy by the Westinghouse Electric Corporation for a special propulsion application. During initial plant tests the Navy determined that the special propulsion application was no longer necessary to its over-all program.

Review of the cycle and plant configuration showed that, with minor modifications, the plant could be used to demonstrate the feasibility of the internally fired closed-cycle unit for man-of-war applications. Tests were therefore conducted which confirmed the following expected advantages of this cycle: (1) essentially constant efficiency over a wide load range (20% to 100% load) by variable pressure level, (2) low air consumption resulting in small inlet and exhaust ducting due to recirculation of cycle gases, (3) low space and weight requirements due to supercharging of the main components, and (4) ease of control, because plant is basically a two-shaft unit.

The gas-turbine unit is designed to operate as follows: The recirculated gas is compressed in the low-pressure compressor, intercooled, and further compressed in the high-pressure compressor. The gas then passes to the regenerator to be heated by the turbine exhaust gases. It is raised to turbine inlet temperature in the combustor and enters the high-pressure turbine which is the power turbine. The gases pass to the low-pressure turbine which drives the compressors. Exhaust from this turbine after regeneration is ducted to both the pump-up turbine and the precooler. The pump-up turbine flow is made up by the pump-up compressor at a rate sufficient to provide oxygen for combustion at all operating conditions. This make-up flow is cooled with the recirculated gases in the precooler to complete the circuit to the low-pressure compressor. The pump-up set is not self-sustaining, and a small amount of power is supplied to it at all conditions by a mechanical connection to the power turbine. A by-pass valve around the pump-up turbine is used for both part-load control and to avoid surge of the pump-up compressor at reduced speed. By-pass valves are also provided for the low-pressure compressor and the power turbine for plant starting, and the low-pressure turbine is clutched to the gear to obtain simultaneous cranking of all equipment used throughout the plant.

Fouling and corrosion of the internally fired, semi-closed-cycle gas turbine were evaluated by the tests. Conventional gas-turbine components are satisfactory for low-sulfur fuel operation, and with additional precooler-equipment development it is expected that high-sulfur fuel operation will be achieved.

Development of High-Speed Sleeve Bearings for a Solar 500-Hp Gas-Turbine Engine,

by D. E. Blackwood, Assoc. Mem. ASME, Bureau of Ships, Department of the Navy, Washington, D. C., and I. M. Swatman, Mem. ASME, Solar Aircraft Company, San Diego, Calif. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-14** (multilithographed; available to Feb. 1, 1957).

The potential advantages of sleeve bearings over antifriction bearings in a gas-turbine engine are discussed. Description is given of the design problems, rig tests, and engine tests to date on a gas turbine adapted to use of sleeve bearings from an earlier design using antifriction bearings.

Advances in the mechanical reliability of other parts of the gas turbine have brought things to a point where engine-overhaul requirements are now limited by the B10 life of the main-shaft antifriction bearings. Depending on the design considerations used, the bearing-life limits of the antifriction-bearing gas turbine may be anywhere from 2000 to 5000 hr. This may not seem too serious when considering the relatively low cost of bearing replacement; but when evaluating this type of power plant for an application, the "down time" for bearing replacement may be an important consideration.

With these factors in mind, the application of sleeve-type bearings, with their inherent longer-life capabilities, would seem to offer important advantages for the small gas-turbine engine. This paper deals with the development of small, high-speed sleeve bearings for such an application and their adaptation into an existing power plant that had been designed to use ball and roller bearings for the main rotor shaft.

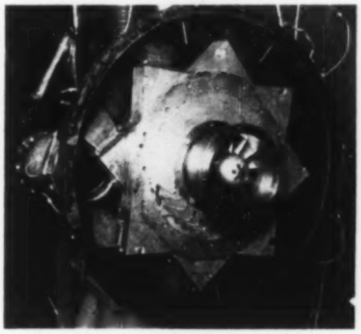
In considering the conversion of the existing-design bearing arrangement to sleeve-type bearings, it was decided to try to achieve a sleeve-bearing design that would be almost interchangeable with the existing antifriction-bearing arrangement. Since the existing bearing housings did not lend themselves readily to modifications to accommodate the larger oil flows required by a sleeve-bearing installation, the turbine-bearing housing and the compressor-inducer casting were redesigned to permit use of a bearing arrangement that would enable the existing turbine and compressor shafts to be used and also would allow the unit to be converted to antifriction bearings should such a conversion be required. The advantage of this feature was that standard-design bearing housings could then be produced and the original-design rotor shafting retained; and, at the customer's preference, either antifriction bearings or sleeve bearings could be used in the final assembly of the engine. The feature was particularly important in considering that the engine may be used for emergency generator-set applications where the unit must be started and accelerated to full load at rated speed in less than 10 sec.

From the results of this development, it appears that a gas-turbine-engine arrangement successfully convertible for either sleeve or antifriction bearings has been obtained. The optimum life of the sleeve-bearing-arrangement engine has not yet been determined. But the simplicity in construction of the bearing arrangement assists in cutting the production cost of the power plant, and takes the small-horsepower gas turbine one step further in its lead over the reciprocating engine in "down time" for overhaul and replacement.

A New Solar Gas-Turbine-Driven Auxiliary Power Plant, by R. Kress, Solar Aircraft Company, San Diego, Calif. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-8** (multilithographed; available to Feb. 1, 1957).

This paper describes the general requirements and past design practices on airborne gas-turbine-driven auxiliary power units, and in addition describes a new solution to the problem—installation of an APU in a streamlined pod. The unit was designed and developed by Solar Aircraft Company for use on the Convair C-131B airplane. Normally two complete pod units are used per airplane, one mounted beneath the wing on each side of the fuselage. Each is attached by means of a standard bomb shackle. Provisions have been made for jettisoning the unit in case of emergency. The paper describes the advantages of a gas turbine as the prime mover in airborne APU applications, the nature of the gas-turbine engine chosen, and its control system.

Development of a Centrifugal Compressor for a Small Gas-Turbine Engine, by N. R. Balling and V. W. Van Ornum, Boeing Airplane Company, Seattle, Wash. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-2** (multilithographed; available to Feb. 1, 1957).



Boeing 502-10 prototype compressor

The objective of the research and development program reported by this paper was to decrease the specific fuel consumption of a small gas-turbine engine by means of an increase in pressure ratio alone. Development of a centrifugal compressor is presented, with a general description of equipment, methods, and special problems met during the tests.

Specific fuel consumption is the most graphic measure of efficiency in an engine and for each turbine operating temperature in the basic gas-turbine cycle there is an optimum cycle pressure ratio which will obtain a minimum specific fuel consumption. For present-day operating temperatures, this optimum ratio lies in the 7:1 to 10:1 range—dependent on component efficiencies. If specific fuel consumption is to be decreased, efficient high pressure-ratio compressors must be developed.

In line with these considerations, the company undertook an engine-development program with the following objective: To decrease the specific fuel consumption of its 502-2 engine by means of an increase in pressure ratio alone. This was both an exploratory and an intermediate step in the development of an engine utilizing the optimum pressure ratio to attain a minimum specific fuel consumption.

The primary objective of this development program—to obtain an SFC = 1.0 by means of compressor development alone—was reached during the course of approximately 60 tests which covered a period of about 14 months. A 5 per cent increase in over-all efficiency of the 502-10 prototype compressor was accomplished. Specifically, this increase was brought about by improving inducer efficiency from 26 to 40 per cent and channel diffuser efficiency from 61 to 79 per cent. Also, because of improved conditions for stability of operation, the vortex-diffuser efficiency was increased from 81 to 83 per cent.

Engine tests revealed that compressor performance on the engine was below that on the component test rig. These tests also demonstrated that the loss of performance was due to burner howl. It was found that the burner howl resulted from an interaction between the characteristic frequency of burner vibration and the compressor-collector volume. Solution of the problem required that the pressure drop across the burner be increased and that the compressor-collector volume be minimized (the maximum value permissible to assure the elimination of burner howl being established by test). Generally, when the conditions of stability of operation of the engine were satisfied, component test data were reproduced on engine tests.

Shadowgraphs of the flow in the vortex diffuser, in conjunction with other tests, revealed that Mach numbers up to 1.3 leaving the impeller created no serious losses. In fact for a well-developed vortex diffuser the losses due to Mach number alone were of the same order as losses due to flow conditions leaving the impeller for peripheral speeds greater than 1300 fps. Semi-empirical methods for the prediction of losses in the vortex diffuser, considering these losses as a function of flow and geometric parameters, were worked out to within engineering accuracy.

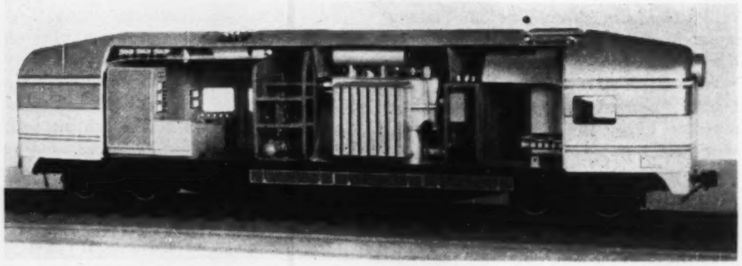
Tests of the impeller components indicated that impeller efficiency was primarily limited by the power-input factor and inducer efficiency. The efficiency of the inducer was limited by inducer-tip relative Mach number. It was also determined that losses in the vortex diffuser were dependent on the flow conditions leaving the impeller. Power-input factor was established by test to be a function primarily of peripheral speed of the impeller and the ratio of impeller-tip diameter squared to the weight flow through the machine.

The efficiency of channel diffusers was limited by throat Mach number as well as by outlet diffusing elbows which affected the stability of flow and the velocity distribution through the channel diffuser. Area coefficients of 0.98 at the throat of the channel diffuser were realized when this diffuser was properly matched to the vortex diffuser.

On the basis of test experience obtained from the program, the following conclusions were drawn: (1) Single-stage compressors can be designed and built up to pressure ratios of about 10:1 (tip speeds between 1800–2000 fps) with adiabatic efficiencies in the range of 75–85 per cent; (2) single-stage compressor efficiency will equal or better two-stage compressor efficiency at pressure ratios in the neighborhood of 7:1; (3) impeller efficiency is limited by power-input factor and inducer efficiency as well as by the requirements of the vortex diffuser; i.e., if the impeller is designed for maximum efficiency without due regard to its effect on vortex-diffuser efficiency, the net result can be a reduced over-all efficiency; (4) the importance of matching compressor components to each other is just as great as the importance of matching turbine and compressor characteristics in an engine; and (5) a straightforward program of experimental testing provides the surest and least expensive route to gas-turbine-compressor improvement.

6200-Kw Gas-Turbine-Driven Mobile Power Plant, by Z. Stanley Stys, Assoc. Mem. ASME, Brown-Boveri Corporation, New York, N. Y. 1956 ASME Gas Turbine Power Conference **56—GTP-4** (multilithographed; available to Feb. 1, 1957).

This portable gas-turbine power plant was designed primarily for use in emergency power shortages. The principal design problem was to accommodate the maximum possible output in a permissible-size railroad car. The large choice of available patterns of gas turbines and axial-flow compressors made it possible to use one of already proved design with these two basic components.



Cross-sectional view of Brown-Boveri 6200-kw portable gas-turbine power plant

The cross section through the power-generating car shows, at the left, the tilted combustion chamber. The regulating fuel valves can be adjusted easily from the control room which is situated at the adjacent end of the car.

A multistage axial-flow compressor is used to supply the compressed air to the combustion chamber as well as for gland sealing and cooling purposes. In the passage of the suction air, an oil cooler was placed to make the plant independent of water supply. Brown-Boveri has operating experience with such coolers which originally were placed in the suction of the 5000-kw gas-turbine-driven generators, of which eight units have been built for Arabian American Oil Company and are located on the desert of Saudi Arabia.

The generator cooling air enters through filters from the sides and is discharged upwards. In the passage of the exhaust gases a fuel preheater is located to heat the heavy crude to the required viscosity.

The whole set (contrary to gas-turbine-locomotive practice, where all machines have separate bedplates) is erected directly on the car frame. The previously mentioned Aramco sets are of the same type of construction. Such arrangement allows very neat auxiliary piping layout as well as weight saving but requires close co-operation of machinery and car manufacturers.

Sufficient expansion joints and other provisions were made to allow for high-temperature gradient due to the short (15 min) starting time from cold to full load. A reaction-type gas turbine with inherently high-efficiency blading was used for expansion of the gases.

Gas Turbine for Mobile Power Unit, by F. O. Hennig, Mem. ASME, Clark Brothers Company, Olean, N. Y. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-10** (multilithographed; available to Feb. 1, 1957).

This paper is a continuation of a previously presented paper ("A 4500-Kw Mobile Gas-Turbine Power Unit," by M. A. Mayers, L. F. Deming, F. O. Hennig, and J. K. Hubbard, ASME Paper No. 53—A-225) which described the over-all design of the major components of a mobile power unit. The present paper is concerned with the main power equipment only and offers a detailed description of the design features which were developed for this project and provide the flexibility necessary to make this gas turbine suitable for other applications.

The compressor is designed to operate at 5000 rpm, employing 13 stages. The rotor is of drum construction and rotor blade root fastenings are of the familiar T-shape configuration. The stator blades are mounted in blade carrier rings which in turn are inserted into the compressor case. This arrangement makes it possible to take out all stator-blade assemblies for inspection, angle adjustment, cleaning, and even replacement without removing the rotor.

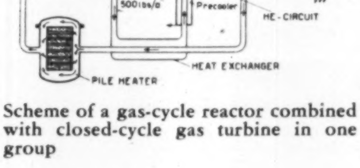
The first or high-pressure turbine driving the compressor has two overhung stages. Forged blades are inserted in axial, serrated slots and integral shrouds at the blade tips provide sealing surfaces running with minimum clearance against the sealing labyrinth strips provided in the stationary-blade assemblies. The two turbine disks are attached to the shaft flange by means of six axial bolts, and concentricity is assured by rabbet fits at all joints between shafts and disks. Precision-cast stator blades are assembled in blade-carrier rings which are supported by radial keys, permitting radial expansion of carrier rings inside the air-cooled turbine-case structure.

In order to minimize expansion problems in the ducting between the combustion chamber and the turbine, the principle of internal insulation and air cooling was employed. An insulated internal hot-gas duct guides the products of combustion to the first-stage turbine nozzle ring. Air from the compressor, by-passing the combustion chamber, surrounds this hot gas duct on its way toward the turbine and is mixed with the hot gas flowing through the inner liner a short distance before the first-stage nozzle. Since the cooling air is essentially at the same pressure as the hot gas, the hot internal duct is not subjected to stresses due to pressure differences and leakage between hot gas, and cooling air is kept to a minimum. The remaining problem is to protect the surrounding outer duct against the temperature of the cooling air which has risen to between 500 and 600 F during its passage from the compressor discharge to the turbine inlet. By attaching insulation to the inside of the outer ducting, the temperature of the pressure-stressed outer duct is reduced to less than 150 F.

The second or power turbine is basically of the same mechanical design as the high-pressure turbine. Radial expansion of stationary parts is accommodated by keys of the same general design as those used in the first turbine. Again, radial struts carry the rotor-bearing case assembly; the same cradle-type support transmits thrust to the base. Due to the lower temperatures involved, internal insulation and air cooling were not used.

Operating Experience and Design Features of Closed-Cycle Gas-Turbine Power Plants, by Curt Keller, Mem. ASME, Escher Wyss Ltd., Zurich, Switzerland. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-15** (multilithographed; to be published in Trans. ASME; available to Feb. 1, 1957).

In this discussion of his experience with closed-cycle gas-turbine power plants, the author summarizes the achievements of Escher Wyss during the past five years. They are based on operation and new design experience and show the marked improvements obtained by simplifying the closed-cycle-system components while keeping the basic properties of the system; this design has led the way to economical solutions in the different fields of application.



Scheme of a gas-cycle reactor combined with closed-cycle gas turbine in one group

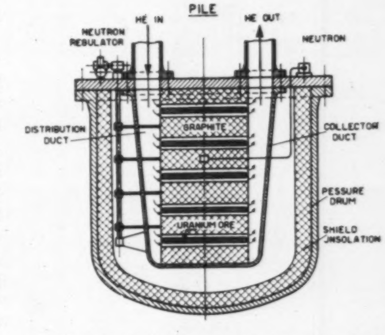
Two major developments are emphasized. One is the successful start of the world's first industrial pulverized-coal-fired plant, which the author considers the outstanding event of last year. The other development is the application of nuclear-reactor heat sources to the closed-cycle gas turbine as working medium and reactor coolant in one loop.

Escher Wyss has concentrated much of its efforts to achieve a coal-burning gas turbine. It has designed and built the first 2000-kw plant which came into operation in Ravensburg, Germany, last December. This plant furnishes the whole electric power for an industrial works of 1500 workers and delivers the necessary heating for the whole establishment and the workshops.

Combination of power and heat production in the closed-cycle plant is very promising. Compared with the corresponding steam plant, the electric output per available heating unit is higher. Power production and heat production are independent of each other. Warm cooling water of the intermediate compressor coolers as well as the precooler of the cycle is available without affecting the power production cycle itself at elevated temperatures of 80–100 C, (175–215 F). The over-all efficiency in such a combination is about 60 per cent; i.e., about 30 per cent of the fuel energy is transferred into electric power and an additional 30 per cent of the fuel energy is transferred in useful process heat.

There is a great trend in Europe to combine power and heat production in thermal plants in view of improved fuel economy. In many parts electric energy costs are high (2 to $2^1/_2$ cents per kwh) even when produced in big steam units. This offers advantages for high-efficiency gas turbines and favors decentralization of power production. The smaller self-contained power units from 5-20 mw are interesting for many countries, especially in Germany where both transmission of electricity and coal transport costs are high. Two more coal-fired plants for isolated town works, one of 12,000 kw and one of 6600 kw, combined with distant heating for the surrounding buildings, have been ordered recently and will come into operation in 1957–58 as a result of the successful starting operation of the pilot plant in Ravensburg.

The author considers the use of a closed helium circuit in a thermal power plant employing atomic energy and concludes that it is feasible. Since helium is neutral to the material of the pile and in addition has advantageous characteristics from the viewpoint of nuclear physics in that, like graphite, it acts as a neutron moderator, the pile could be brought in direct contact with the gas. The pile might, in fact, possibly be arranged in a pressure vessel as indicated in the diagram of the pressure reactor proposed in 1945.



1945 proposal of pressure gas-cooled graphite uranium reactor

The helium issuing from the compressor of the circuit could be supplied to the pile under a high pressure of 700–1400 psi—for increasing the heat transmission figures and reducing the dimensions—and would afterwards flow in direct contact as a cooling medium around the uranium rods, as also through bores in the graphite itself. In this way the pile would give up the heat which it produces by direct convection to the helium.

Under the above-mentioned assumptions (increased pressures) the large quantities of heat produced in the pile will, on account of the good heat transmission, be capable of being usefully taken up. In this manner no tubes would be required for the helium heater. Calculations show that if a pile temperature of 1500 F is assumed as admissible, only a very small surface is needed to heat up the circulating helium to 1300 F.

American Turbine Corporation and Escher Wyss have been developing designs particularly adapted to United States requirements. The simplicity and the high efficiency of the closed-cycle power plant system makes this plant especially desirable for nuclear application. Accordingly, a 10–15 mw set has been designed which meets the requirements for a wide range of possible applications. Axial machinery was chosen for plants above 10 mw because of its compactness and high efficiency. Pure nitrogen is used as a working fluid when employed in a nuclear plant.

Gas-Turbine Rotary Regenerator—Design and Development of Prototype Unit for 3000-Hp Plant, by W. E. Hammond, Mem. ASME, and T. C. Evans, Mem. ASME, The Air Preheater Corporation, Wellsville, N. Y. 1956 ASME Gas Turbine Power Conference paper No. **56—GTP-5** (multilithographed; available to Feb. 1, 1957).

The purpose of this paper is to emphasize the advantages of the regenerative cycle, generally, and, more specifically, to show why the rotary type is most promising, particularly in the high effectiveness range.

To exploit the regenerative gas-turbine cycle to the fullest possible extent requires an extremely high degree of heat exchange. Presently, the rotary heat exchanger is the only type which can be designed with the high thermal effectiveness necessary and yet remain practical from a size and cost standpoint. The mechanical nature of the rotary heat exchanger is such, however, that some leakage of high-pressure fluid to the low-pressure side will always occur. The fact that in the past this leakage could not be held to workable values has prevented commercial acceptance of this type unit.

The Air Preheater Corporation set up an intensive program aimed at developing an acceptable sealing means which would remove this one objection to an otherwise highly desirable piece of equipment. While this development program is far from complete, results to date have indicated that sealing of the rotary design can be accomplished, and, based on quantity production, costs of a turbine plant equipped with a rotary heat exchanger would be attractive commercially. Included in the development program were the design and construction of a prototype unit for a 3000-hp turbine plant. While erection of the prototype unit is complete, no testing had been done at time of writing.

ASME Transactions

for July, 1956

The July, 1956, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers), contains the following technical papers:

Behavior of Air in the Hydrostatic Lubrication of Loaded Spherical Bearings, by T. L. Corey, C. M. Tyler, Jr., H. H. Rowand, Jr., and E. M. Kipp. (54—LUB-8)

Power Loss in Elliptical and three-Lobe Bearings, by Oscar Pinkus. (55—LUB-9)

Prediction of Lubricating-Oil Viscosities at High Pressures, by O. H. Clark. (54—SA-39)

On the Evaporation of a Drop of Volatile Liquid in High-Temperature Surroundings, by W. E. Ranz. (54—A-143)

Turbulent Flow in the Entrance Region of a Pipe, by Donald Ross. (54—A-89)

An Experimental and Analytical Investigation of a Differential Surge-Tank Installation, by W. L. Gibson and W. Shelson. (54—A-138)

Density-Temperature-Pressure Relations for Liquid Lubricants, by H. A. Hartung. (55—LUB-7)

Finite Journal Bearings With Arbitrary Position of Source, by J. V. Fedor. (55—LUB-14)

Very Short Journal-Bearing Hydrodynamic Performance Under Conditions Approaching Marginal Lubrication, by L. F. Kreisle.

Analysis of Elliptical Bearings, by Oscar Pinkus. (55—LUB-22)

Experimental Investigation of Resonant Whip, by O. Pinkus. (55—LUB-23)

Varieties of Shaft Disturbances Due to Fluid Films in Journal Bearings, by B. L. Newkirk. (55—LUB-12)

Effect of Combustion-Resistant Hydraulic Fluids on Ball-Bearing Fatigue Life, by H. V. Cordiano, E. P. Cochran, Jr., and R. J. Wolfe. (55—LUB-21)

Operating Characteristics of High-Speed Ball Bearings at High Oil-Flow Rates, by C. C. Moore and F. C. Jones. (55—LUB-10)

Thermal-Cycling Test of a Hot Spot on a Vessel, by P. N. Randall and H. A. Lang. (55—PET-2)

Some Cases of Stress Due to Temperature Gradient, by D. J. Bergman. (55—PET-12)

High-Temperature Stability of Insulating and Refractory Castables in Reducing and Oxidizing Atmospheres, by C. M. Vogrin and H. Heep. (55—PET-31)

Yield and Bursting Characteristics of Heavy-Wall Cylinders, by J. H. Faupel. (55—PET-1)

Ebullition Cooling of Gas Engines, by G. O. Bates, J. E. English, and G. M. Franklin. (55—PET-18)

Resistance Coefficients for Accelerated and Decelerated Flows Through Smooth Tubes and Orifices, by J. W. Daily, W. L. Hankey, Jr., R. W. Olive, and J. M. Jordaan, Jr. (55—SA-78)

Streamlined Pitot-Tube Bar for Measuring Water Flow in Large Pipe, by F. Numachi, H. Murai, and S. Abe. (55—SA-25)

A Comparison of Regenerative-Pump Theories Supported by New Performance Data, by Yasutoshi Senoo. (55—SA-44)

Process Design of Tubular Heaters, by L. A. Mekler. (55—SA-27)

On the Tool-Life and Temperature Relationship in Metal Cutting, by F. F. Ling and Edward Saibel. (55—SA-23)

The Mechanism of Crater Wear of Cemented Carbide Tools, by K. J. Trigger and B. T. Chao. (55—SA-11)

Chatter Vibration of Lathe Tools, by S. Doi and S. Kato. (55—SA-22)

Study of Die Wear by Means of Radioactivated Surfaces, by B. J. Jaoul. (55—SA-24)

Hydraulic-Turbine Runner Vibration, by R. M. Donaldson. (55—A-130)

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56—APM-30	A Theory for Base Pressures in Transonic and Supersonic Flow, by H. H. Korst
56—APM-31	The Boundary Layer Inside a Conical Surface Due to Swirl, by H. E. Weber
56—APM-32	Three-Dimensional and Shell-Theory Analysis of Axially Symmetric Motions of Cylinders, by G. Herrmann and I. Mirsky
56—APM-33	Minimum Weight Design of Cylindrical Shells, by W. Freiberger
56—APM-34	A New Method of Analyzing Stresses and Strains in Work-Hardening Plastic Solids, by W. Prager
56—APM-35	On the Transmission of a Concentrated Load Into the Interior of an Elastic Body, by G. L. Neidhardt and E. Sternberg
56—APM-39	Effect of Imperfections on Buckling of Thin Cylinders Under External Pressure, by L. H. Donnell

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Paper No.	*Title and Author*
56—APM-25	The Influence of Blast Characteristics on the Final Deformation of Circular Cylindrical Shells, by P. G. Hodge, Jr.
56—APM-36	Axisymmetrical Buckling of Circular Cones Under Axial Compression, by P. Seide
56—APM-37	Transient Response of a Nonlinear System by a Bilinear Approximation Method, by E. I. Ergin
56—APM-38	Electronic Analog Computer Solutions of Nonlinear Vibratory Systems of Two Degrees of Freedom, by C. P. Atkinson
56—APM-40	Kinematic Phenomena Observed During the Oblique Impact of a Sphere on a Beam, by W. Goldsmith and D. M. Cunningham
56—APM-41	An Experimental Investigation of Beam Stresses Produced by Oblique Impact of a Steel Sphere, by D. M. Cunningham and W. Goldsmith

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Tribute to James E. Davenport

To the Editor:

I read with a sense of deep loss and regret the news of the death of Mr. James Eggleston Davenport, as announced in the obituary column of Mechanical Engineering.

After reading this obituary, it seemed quite inadequate as a record of the life and work of a man of remarkable courage and initiative. It is rare to find a top-level company executive who has the courage to underwrite a new enterprise, failure of which might jeopardize his position, attained after a lifetime of endeavor.

I would like to point out additional important achievements of Mr. Davenport, a procedure which I am sure will be heartily approved by his many friends among the top-level executives of American locomotive and engine companies.

Mr. Davenport was for many years superintendent of the West Shore Division of the New York Central Railroad, where he had 18,000 people under his supervision, one of our most vital east-west freight arteries.

Under the aegis of Mr. Davenport as head of engineering and research of American Locomotive Company during World War II, one-quarter billion dollars worth of highly technical equipment was delivered to the allied forces, including the first tanks with gyroscopic gun control to be produced by the United States.

Mr. Davenport was for many years a trustee of the Georgia Institute of Technology and one of a few men entrusted with the selection of their recently deceased President, Blake van Leer. Mr. Davenport was also for many years on the Board of Governors of the New York Railroad Club, the premier management railroad club of the United States. He was also for many years a member of the Union League of New York.

I recall enjoyable luncheons with Mr. Davenport in which he would recount his adventures as a young man building a railroad through the "feudin' country" in the hills of West Virginia and Tennessee.

I am sure that the many friends acquainted with Mr. Davenport during his lifetime will appreciate this effort to render a final tribute to a man of high courage, integrity, and initative.

R. E. Bruckner.[1]

Petrochemical Industry*

Comment by R. E. Loebeck[2]

The authors[3] have summarized well the developments in instrumentation by the petrochemical industry. The highly competitive positions of process industries and instrument manufacturers have forced instrument development at a fast pace since World War II and we appear to be on the threshold of a new era in automatic control systems which may be astounding.

It was of interest to us to note one of the examples used in this paper; namely, ratio flow control of two gas streams in process, illustrated in Fig. 2. Phillips Petroleum Company used this system on a unit placed in operation in September, 1948, and was granted a patent (Briggs-Loebeck 2,515,490) in 1950. The Brown Instrument Company built the pneumatic set ratio controller special and so far as we know it was the first built and used.

For the flow-sensing cell illustrated in Fig. 6, it might be added that manufacturers are claiming, in addition to well over a 5000-psi pressure range, the cell will work in temperatures up to 1200 F and has an over-all accuracy of plus or minus $^1/_2$ per cent. At present the line size seems to be limited to a maximum of 4 in. The authors mention the ease of servicing. We are wondering if they mean removing the cell and putting another in its place. Also, we are interested in knowing how much wear is encountered on the moving parts in the flowing stream. This usually has been the problem of moving-vane meters in the past, particularly in corrosive and high-temperature services.

Comment by J. J. Combes[4]

In general this paper is not conducive to detailed or specific comments since it is mainly a description of instruments and methods used by the authors in their plant and which, from their statements, appear to have worked out satisfactorily.

Our previous field-instrumentation experience leads us to agree with the instruments and methods they used. However, there are two questionable points as follows:

1 From their description of strain gages we wonder why they did not use a completely electrical circuit to the controller which then could have a pneumatic output. Strain gages are available which are wired up to controllers in a way similar to resistance thermometers.

2 In their description of sealed meters we feel that a suitable purge system always should be provided in a chemical plant processing corrosive substances. We never yet have seen an application where a suitable purge substance couldn't be provided although there are times where, for process reasons, no extraneous liquids or gases can be bled into the system, although this is extremely rare.

We have had very poor experience with sealed meters as follows: With Kell-F and Teflon seals osmosis took place and the process material and seal-filling material interchanged. Flexible leads between the instrument and the sealing diaphragm were used and were easily damaged. Errors occurred owing to set in seal diaphragms. Errors occurred as a result of temperature effects on differential meters where each lead was not constantly exposed to the same temperature, say, due to sunlight. Errors occurred from out-gassing of seal liquid in vacuum service. If seals are used it is not absolutely necessary to have both seals at the same level. This last error can be compensated for in suppressing the instrument's zero point. In view of the troubles we have had with sealed meters on a previous job we removed almost all of them and replaced them with purged systems.

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[1] Atomic Power Division, Westinghouse Electric Corporation, East Pittsburgh, Pa. Mem. ASME.

[2] Phillips Petroleum Company, Bartlesville, Okla.

[3] Developments in Instrumentation by the Petrochemical Industry, by R. G. Marvin, W. L. Stuart, G. W. Lunsford, and E. E. Ludwig, Mechanical Engineering, vol. 78, February, 1956, pp. 132–134.

* Parts of this discussion refer to the complete paper, No. 55—PET-4, and not to the condensed version publisned in Mechanical Engineering.

[4] The M. W. Kellogg Company, New York, N. Y.

Comment by T. A. Abbot[5]

The problems of instrumentation in the petrochemical industry which are described in the paper indicate the difficult problems which the instrument engineer has been called upon to solve.

It was particularly interesting to see the many instances where it was necessary or desirable to combine in one system the use of both electrical and pneumatic systems to solve a particular problem.

A few years ago instrumentation of a unit was essentially pneumatic with electrical instruments used primarily for temperature measurements. The conditions of high-pressure, more sensitive flow measurements, and particularly more rapid response have resulted in the use of more electrical instruments. It now is evident that the one piece of equipment that the pneumatic system has that the electrical system has yet to satisfactorily duplicate is the pneumatically operated control valve. When the electrical industry can offer an electrical valve with the accuracy of setting and speed of response of the pneumatic valve, then, particularly in expensive installations such as those in the petrochemical industry, the pneumatic instruments will be obsolete and the electrical systems will be used exclusively.

Authors' Closure

The authors appreciate Mr. Loebeck's comments. In reference to his last paragraph, we believe it was pointed out at the time of the meeting presentation that experience had not been obtained in the service of the flow-sensing cell shown in Fig. 6 of the complete paper; however, an analysis of the over-all setup pointed to the advantages suggested by the authors. Experience since the time of the preparation of the paper has indicated reasonably good service for the application and would suggest that it is still applicable in many places not properly serviced by other flow devices.

We would not necessarily suggest the application in extremely corrosive services; however, they undoubtedly can and will be developed as the need requires.

Mr. Combes' comments and specifically his mention of an error in the illustration for the strain-gage circuitry are welcomed. Actually the installation was as suggested by Mr. Combes, namely, a completely electric circuit; the pneumatic connections were not included. The write-up by the authors indicated this; however, the diagram was not corrected.

In reference to paragraph number 2, of the comments, we have found that purging in the presence of bromines and ethylene dibromide has been a real problem. Here, suitable purge liquid was not available and it was not considered safe to purge with ethylene gas or other material of this nature. Air could not be tolerated. In other words, this is one of the extremely rare instances suggested by Mr. Combes. The experience with the sealed meter has been good and the problems of osmosis were not observed. Of course, it is necessary to pick a suitable material for the service application. We would agree that sealed meters should be used only where a purged system could not be devised.

The authors are grateful for the comments of Mr. Abbott.

R. G. Marvin.[6]
W. L. Stuart.[6]
G. W. Lunsford[6]
E. E. Ludwig.[6]

The Scientist's Beliefs

Comment by H. Leslie Bullock[7]

This paper on the subject of the scientist and his escape from materialism[8] has been read with much interest.

Ever since entering Columbia University in 1914 under the broad six-year engineering course which was then in force, I have felt that our engineering studies should include courses in the humanities. However, I confess that my interest was in broadening the engineer so that he might be of more service to the community rather than a desire to protect his faith or save him from materialism.

In a group of engineers, as in all other human groups, you will find all gradations of character, of faith, and of materialism. Perhaps I have been fortunate in my engineering contacts, but I feel that the engineers compare very favorably with any other group.

Engineers seem to be able to appreciate the full meaning of the text, "Render to Caesar the things that are Caesar's . . ." They seem to realize that the very orderliness of the material world makes it worthy of celestial creation. They recognize the limitations of our methods and instruments in our rapidly expanding fields of knowledge. They are inclined to have faith in a system which makes it possible to postulate and then discover bodies ranging from the meson to a planet.

The "Warped, wooden, stunted human beings, 'slide-rule engineers,'" mentioned by the author, may become evident in our graduate engineers, but I do not think that we should blame solely engineering education for their production. A boy can begin to lose faith in a modern grade school when he is not taught to revere and have faith in our democracy and in the men who made it possible. Later, if he is taught religion, philosophy, history, and economics as a spectator and not as a member of responsible humanity, he can easily lose faith. The story of the progress from Jah-weh to Jehova and then to a Christian God; the study of deism, pantheism, and theism; the record of man's inhumanity to man and of Christian justification of slavery as late as the nineteenth century—all these make their mark on the young mind according to its own quality. If the student, in all courses, does not recognize the limitations of our evolving methods and instrumentation, if he does not realize that his parents were, that he is, and that his children will be, active and responsible participants in our upward struggle, he is welcome to his lack of faith and abnegation.

Study of materialistic engineering science may destroy religious faith and promote materialism in a fairly large number, but if their teaching is proper, there is no reason why they should become, "warped, wooden, stunted human beings."

If the modern engineer finds that it is hard for him to love a rather abstract and impersonal God, he can do as Abou Ben Adhem did, take refuge in loving his fellow men, and I believe, feel just as certain of God's blessing.

If he is not able to believe in a rather materialistic Heaven of golden streets and pearly gates, in forgiveness and a life everlasting, I do not fear him or for him.

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[5] Engineering Research Department, Standard Oil Company (Ind.), Chicago, Ill. Mem. ASME.

[6] Authors are, respectively, Group Leader, Instrument Section; Instrument Engineer; Inorganic Project Manager; Process Design Manager; Engineering Department, The Dow Chemical Company, Freeport, Texas.

[7] Director, Bullock-Smith Associates, New York, N. Y. Mem. ASME.

[8] "Science Changes the Scientist Too!" by Gilbert E. Doan, MECHANICAL ENGINEERING, vol. 78, March, 1956, pp. 231–232.

John Ruskin has summed up this situation so satisfactorily in the introduction to his "Crown of Wild Olive," where he says, "But to men, whose feebleness of sight, or bitterness of soul, or the offense given by the conduct of those who claim higher hope, may have rendered this painful creed the only possible one, there is an appeal to be made, more secure in its ground than any which can be addressed to happier persons. . . . . . In them (the Believing) it may be no sign of hardness of heart to neglect the poor, over whom they know their Master is watching; and to leave those to perish temporarily, who can not perish eternally. But, for you, (the Materialist) there is no such hope, and therefore no such excuse... Is it therefore easier for you in your heat to inflict the sorrow for which there is no remedy?...Will you be readier to the injustice which can never be redressed; and niggardly of mercy which you can bestow but once and which refusing you refuse forever? I think better of you, even of the most selfish, than that you would do this, well understood. . ."

Let us so arrange our teaching and our business and social contacts, to insure that the engineer and scientist think first of others and that his reactions and actions are "well understood." Our fears for the individual and for mankind will be greatly diminished.

Comment by C. J. Freund[9]

It seems to me that Gilbert Doan's paper is one of the most significant that has appeared in any technical publication in many years.

I am afraid, though, that most engineers will either fail to grasp what Doan has to say or reject his idea. Some years ago Mechanical Engineering published a piece by Dr. Sinnott on much the same subject. If I remember correctly, it created almost no comment or interest.

I shall never be able to understand how engineering methods or scientific research alone can solve any problem which is exclusively spiritual or intellectual, or otherwise not pertaining to material or physical matters. Nor is it possible for me to rationalize the process by which the researcher who condemns everyone accepting anything on faith, himself is obliged to take on faith the very basis of his research; i.e., that the quantitative experimental method is the only approach to the truth.

Dr. Doan certainly thrusts sharply at viewpoints which have long been well entrenched. I, for one, think he is right.

Comment by Edmund W. Sinnot[10]

I should like to endorse most warmly the article by Gilbert E. Doan which appeared in the March number of Mechanical Engineering. It seems to me that this emphasizes a point in the education of young scientists and engineers about which too little has been said.

Author's Closure

Mr. Bullock says his "interest is in broadening the engineer so that he might be of more service to the community rather than a desire to protect his faith or save him from materialism." Actually faith and community consciousness are cause and effect, not to be separated.

Gilbert E. Doan.[11]

Nickel-Base Alloys

Comment by S. G. Demirjian[12]

This is an excellent presentation,[13] particularly in the explanation of the vacuum-melting process and technique. The writer's experience being that of a consumer, he will offer his comments from that viewpoint.

The authors have discussed Waspalloy primarily, only slight mention being made of M-252 alloy, which is an alloy used quite extensively by the writer's company. Generally speaking, in our experiences with M-252 alloy, which is a nickel-base alloy, there has been a very wide scatter in stress-rupture life, stress-rupture ductility, and tensile ductility. It is agreed that vacuum-melted M-252 is superior to air-melted M-252 in all respects.

Obviously, vacuum-melting is a relatively new field in so far as the production of high-temperature alloys is concerned and, as such, still has problems. The problems are not only in melting but also in converting ingots into bar stock. Eventually time will overcome the melting and conversion problems to produce more consistent properties. Based on the results of more recent heats, some progress is apparently being made.

However, in the field of high-temperature alloys, experience has taught that sound conclusions can be made only after evaluating the performance and results of a large number of heats.

The foregoing comments are based on the sum total of our experiences with vacuum-melted M-252 received from all of our suppliers. The authors are to be congratulated on the clarity and content of a timely paper.

Authors' Closure

The authors wholeheartedly agree with Mr. Demirjian's comments, especially his remarks concerning conclusions that can be drawn only after evaluating the performance and results of a large number of heats. It is due to this reason that our mention of M-252 was somewhat sketchy. Up to the time the article was being prepared the number of heats of M-252 melted were much fewer than Waspaloy. At the present time, however, a great many more heats of M-252 have been melted and our results agree completely with Mr. Demirjian's observations of this alloy.

The authors are also very grateful to Mr. Demirjian for pointing out a fact that is seldom realized—the importance of the conversion practices on the final properties of wrought heat-resisting alloys. However, since the melting practice comes first the introduction of vacuum-melting techniques has proved invaluable in providing material with sufficient melting consistency so that the subsequent effects of conversion could be unscrambled and studied in greater detail than has been possible in air-melted material.

The problems of melting in vacuum are slowly being unfolded and a great deal of important work is being done not only in our laboratory but in other laboratories, that we feel will have a tremendous effect in the near future on our understanding of the importance of melting techniques and compositions on the behavior of the high-temperature alloys.

F. N. Darmara.[14]
J. S. Huntington.[15]

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[9] Dean, College of Engineering, University of Detroit, Detroit, Mich. Fellow ASME.

[10] Dean, Yale University Graduate School, New Haven, Conn.

[11] Manager of Metallurgical Research, Koppers Company, Inc., Pittsburgh, Pa.; Head of Department of Metallurgical Engineering at Lehigh University, 1939–1952.

[12] Supervisor, Materials and Processes Engineering Unit, General Electric Company, West Lynn, Mass.

[13] "Vacuum-Melting Nickel-Base Alloys on a Production Scale," by F. N. Darmara and J. S. Huntington, Mechanical Engineering, vol. 78, April, 1956, pp. 323–326.

[14] Vice-President and Manager, Metals Division, Utica Drop Forge & Tool Corporation, Utica, N. Y.

[15] Assistant to Division Manager, Metals Division, Utica Drop Forge & Tool Corporation, Utica, N. Y.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Forestry

Forestry Handbook. Edited for the Society of American Foresters by Reginald D. Forbes and Arthur B. Meyer. The Ronald Press Co., New York, N. Y., 1955. Cloth, 6 × 9 in., figs., bibliographies, index, ix and 1143 pp., $15.

Reviewed by Frederick F. Wangaard[1]

This handbook, eight years in preparation and representing the combined effort of 145 consulting and contributing editors, brings for the first time to the field of forestry a reference work of a type familiar to engineers through their various handbooks.

Well organized into 23 indexed sections covering every phase of forestry and a number of related fields, this single volume presents in concise form basic factual data and techniques essential to the practitioner of forestry. Of particular interest to engineers are the sections on fire, watershed management, logging, surveying, forest-road engineering, utilization and wood technology, and chemistry and physics of wood.

The section on protection against fire deals in part with equipment for fire suppression and hence is a meeting ground for foresters and mechanical engineers concerned with the development of such equipment. The ASME has long encouraged interprofessional co-operation in this area through its Forest Protection Committee of the Wood Industries Division.

Under watershed management, the handbook deals with the hydrologic cycle, precipitation, transpiration, evaporation, infiltration, soil moisture, runoff and streamflow, erosion, use of water, and water units and measurements.

A major portion of the section on logging is devoted to mechanical transportation of logs by tractors, cable systems, motor truck, and railroad. Considerable information is given relative to operating costs and production rates obtainable under various conditions.

Sections on surveying and road engineering provide the engineer with a convenient reference to those aspects of these subjects peculiar to forestry applications. Included are methods suited to forest-land surveys, standards for truck roads, road construction and maintenance, and design data for log stringer bridges.

One of the sections of major interest from an engineering standpoint is that on utilization and wood technology. This is a brief wood handbook covering lumber manufacture, specifications and grades, identification of wood, physical and mechanical properties, wood fastenings, lumber seasoning, wood preservation, veneer and plywood, hardboard, containers, and pulpwood. Together with the section on chemistry and physics of wood, this portion of the Forestry Handbook serves as a convenient source of useful information on wood for the engineer working in any branch of the forest products industries.

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[1] Manufacturers' Association, Professor of Lumbering, Yale University, New Haven, Conn. Member ASME.

Books Received in Library

ASTM Standards on Textile Materials. Published 1956 by the American Society for Testing Materials, Philadelphia, Pa. 761 p., 6 × 9 in., paper. $5.75. These standards cover testing machines; humidity testing; identification and qualitative analysis; quantitative analysis; fibers; textiles made of asbestos, bast and leaf fiber, cotton, glass, rayon, acetate, silk, and wool; and warp knit, pile, and unwoven fabrics. Twenty-two of the standards are new or revised since the previous edition was published in 1954.

Ausgewählte Plattenprobleme. By Mohamed M. El-Hashimy. Mitteilungen Institut für Baustatik No. 29, E.T.H., Zürich, 1956. Verlag Leemann, Zürich, Switzerland, 96 p., $6\,^1/_8 \times 8\,^3/_4$ in., paper. 10.40 Sw.Fr. This doctoral dissertation deals with three selected problems in plate theory, presenting either rigorous or approximate mathematical analyses of the following: eccentrically loaded circular ring plates with fixed outer and inner edges; two-dimensional influence areas in circular plates; rectangular plates having cutout sections.

Bibliographie der Veröffentlichungen Über den Leichtbau und Seine Randgebiete im Deutschen und Ausländischen Schrifttum aus den Jahren 1940 bis 1954. By H. Winter. 1955, Springer-Verlag, Berlin, Germany. 1003 p., $5^7/_8 \times 8^3/_8$ in., bound. 80 DM. A comprehensive bibliography of books and articles, mainly German, French, British, and American. The books are separately listed and are arranged, as are the articles, in two broad divisions covering basic information and applications. In the first division are references dealing with such subjects as safety factors, statics, vibration, deformation weight-saving methods, joints and connections, standards, and design. Under applications are listed references on materials, general mechanical engineering, transportation, aeronautical engineering, crane construction, structures, and so on. The introduction, table of contents, and outline of subjects are in both English and German. The subject index is in German only.

Chromium-Nickel Austenitic Steels. By F. H. Keating. 1956, Butterworths Scientific Publications, London, England, 138 p., 6 × 10 in., bound. 25s. The main subjects dealt with are mechanical and physical properties; methods for chemical analysis; and manufacturing and fabricating processes, including melting and casting, hot and cold working, machining, and welding. The metallurgy of these types of steels is briefly discussed, their development is reviewed, and a separate chapter is devoted to corrosion resistance. The treatment is primarily practical with only enough theory included to give the necessary background.

Circular Cylindrical Shells. Kreiszylinderschalen. By D. Rüdiger and J. Urban. 1955, B. G. Teubner Verlagsgesellschaft, Leipzig, Germany. 270 p., $6^3/_8 \times 9\,^1/_8$ in., bound. 24.50 DM. A tabular compilation of internal forces and displacements for computing circular cylindrical shell structures of arbitrary dimensions. The book also contains an introduction to the theory and practical examples of application. This is a bilingual edition, the text being both in German and English.

Colloquium on Fatigue. (International Union of Theoretical and Applied Mechanics, Stockholm, Sweden, 1955.) Edited by W. Weibull and F. K. G. Odqvist. 1956, Springer-Verlag, Berlin, Germany. 339 p., $6^1/_4 \times 9^3/_8$ in., bound. 46.50 DM. The present volume contains the thirty-five papers presented at the Colloquium in full, with discussions. Among the topics dealt with are statistical theory of fatigue, cumulative damage, mechanism of fatigue, velocity of fatigue cracks, fatigue at elevated temperatures, and fatigue at combined stresses. About half the papers are in English, the remainder in French or German. The subject index is given in all three languages.

Davison's Textile Catalogues and Buyers' Guide. 1955 edition. Davison Publishing Company, Ridgewood, N. J., 1956. 449 p., $8^3/_8 \times 11^1/_4$ in., bound. $12. Illustrated catalogues or announcements of over three hundred firms dealing in machinery and equipment or offering supplies or services are included, along with a classified buyers' guide covering many additional firms, and a list of brands and trade names of chemicals, dyes, oils, soaps, and other products. One section is devoted to engineering, contracting, and special services.

Die Berechnung der Kräfte und des

Arbeitsbedarfs bei der Formgebung im Bildsamen Zustande der Metalle. By Alexander Geleji. Second edition, 1955. Hungarian Academy of Sciences. Available from Kultura, Budapest, Hungary. 415 p., $6^3/_4 \times 9^5/_8$ in., bound. Price not given. A comprehensive mathematical analysis of forces and power requirements in the plastic working of metals. Beginning with a chapter on the fundamentals of plastic deformation, the author deals successively with forging and pressing, rolling, wire drawing, combined drawing and rolling, extrusion, tube forming, bending, and deep drawing. In addition to the illustrative diagrams the book also contains many fully worked-out examples for the practical engineer and tool designer.

Essentials in Problem Solving. By Zuce Kogan. Second edition, 1956, Arco Publishing Company, Inc., New York, N. Y. 119 p., $5^3/_8 \times 8^1/_4$ in., bound. $4. The essential element in solving problems, as the author, a consulting engineer, sees it, is the development of general methods of approach that can be adapted to specific cases. In this small book he discusses the formulation, adoption, and utilization of a number of approaches he has found useful and selects four for amplification and illustration. These are: for more without adding, utilize fully; to detach, attach something else; when continuity fails, alternate; and when the direct way fails, try the opposite.

Impianti Idroelettrici. By Felice Contessini. Second edition, 1956, Libreria Cesare Tamburini, Milan, Italy. 409 p., $6^3/_4 \times 9^3/_4$ in., bound. 5000 lire. This text and reference book covers precipitation measurement, stream gaging, and other fundamentals; the principles of water-power utilization; dams, tunnels, intakes, central stations, and associated components; and costs and legal considerations. In addition, the book includes a fairly extensive section giving descriptions of individual European plants of various types.

Kleines Handbuch Technischer Regelvorgänge. By Winfried Oppelt. Second edition 1956, Verlag Chemie, Weinheim, Germany. 555 p., $6^1/_2 \times 9^1/_2$ in., bound. 36 40 DM. This manual on industrial-control systems describes the design and construction of the more important control devices and presents the mathematical fundamentals for the solution of control problems. Charts and diagrams are profusely used to illustrate the characteristics of the various devices and systems covered. The new edition has been considerably revised and enlarged, but the 600-item bibliography has been omitted owing to the availability of more comprehensive ones elsewhere. A shorter list of pertinent books and periodicals has, however, been included.

Manual of Technical Reference of the Cold Rolled Sections Association. 1955, Cold Rolled Sections Association, Birmingham, England. Various pagings, $9 \times 10^7/_8$ in., loose-leaf binding. 42s. Tables of safe loads, dimensions, and properties of standard British cold-rolled-steel sections are included, along with supplementary data such as geometrical properties of elements, properties of materials, and strip-steel weights. An introductory section gives information on the rolling process, machine operations, fabricating, protective treatments, storing, and packing. Numerous fold-out drawings and photographic reproductions of structural applications are also included.

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Mathematics Refresher for Professional Engineers' and Land Surveyors' License. By John D. Constance. First edition, 1956, published by John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J. Various paging, $8^3/_8 \times 10^7/_8$ in., paper. $2. A collection of problems, with solutions, explanations, and illustrative diagrams, based on examinations given in a number of states. The problems cover the subject from algebra through calculus and are supplemented by a number of pages of reference data.

Notes: Basic Engineering Sciences. By C. E. Harrington. Third edition, 1956. Published by the author, 45 Elk Street, Springville, N. Y. 161 p., $8^3/_8 \times 11$ in., paper. $3.50. Intended as an aid to engineers preparing for New York State professional engineering examinations, this publication briefly reviews fundamentals and illustrates methods of solutions of problems by including 263 answered questions from previous examinations. The new edition contains additional material on kinematics, gears, vibration, gas-engine cycles, heat transmission, and other subjects.

Office Work and Automation. By Howard S. Levin. 1956, John Wiley & Sons, Inc., New York, N. Y. 203 p., $5^7/_8 \times 9^1/_4$ in., bound. $4.50. A discussion, for business executives, of the possible applications to office work of new methods of handling information. Five-channel, punched, paper tape, punched cards, and magnetic tape are suggested as methods for integrated data recording; electronic data-processing machines are considered as tools for processing information; and operations research is discussed as an approach to the effective use of information. The probable effects of mechanization on management control, office organization, and employees are explored in the last chapter.

Plant Location in Theory and in Practise. By Melvin L. Greenhut. 1956, The University of North Carolina Press, Chapel Hill, N. C. 338 p., $6 \times 9^1/_4$ in., bound. $7.50. The four parts of this study deal, respectively, with the historical development of location theory, specific factors of location, site-selection of the small firm, and the author's general theory of plant location. The discussion includes an analysis of the influence of transportation, processing costs, and competitor locations on the selection of plant sites, and also considers such factors as close contact with bankers, raw-material suppliers, and customers. The chapters on small-plant location are based on an empirical investigation of eight firms in Alabama. A bibliography is included.

Principles of Turbomachinery. By D. G. Shepherd. 1956, The Macmillan Company, New York, N. Y. 463 p., $6 \times 9^1/_4$ in., bound. $10. The first part of this volume is a general treatment of principles applicable to all types of turbomachines—dimensional analysis, energy transfer, thermodynamics of compressible flow, and the flow of fluids in ducts and over blades. The last part is devoted to the analysis, from the viewpoint of the mechanical engineer, of the performance of centrifugal and axial-flow compressors and pumps, and radial and axial-flow turbines.

Proceedings of the Ninth Annual Conference on the Administration of Research. Northwestern University Technological Institute. Evanston, Ill. 1956, New York University Press, New York, N. Y. 107 p., $8^3/_8 \times 11$ in., paper. $4. These proceedings contain nine papers dealing with the research relationships between government and industry and government and the university. Viewpoints of university and industry executives are given and methods for improving relationships are discussed. One of the papers is a summary of statistical data on government-sponsored research. A panel discussion on the future of research is also included.

Running and Maintenance of Marine Machinery. By various authors. Fourth edition. 1955, The Institute of Marine Engineers, London, England. 231 p., $7^1/_4 \times 9^7/_8$ in., bound. 17s,3d. A completely rewritten edition of a standard British text intended both as an introduction to the subject for junior engineers and as a review of the best current practice for senior engineers. Various authorities have contributed the separate chapters which deal with boilers, fuel, steam-reciprocating machinery, steam turbines, electrical machinery, diesel engines, refrigerating machinery, pumping arrangements, and steering gears.

Tables of the Function Arc Sin *Z*. (The Annals of the Computation Laboratory, volume 40). 1956, Harvard University Press, Cambridge, Mass. 586 p., $7^3/_4 \times 10^3/_4$ in., bound. $12.50. In this presentation of tables of the inverse sine in the complex domain both the argument and the function are given in Cartesian form, and six decimal places are provided. As in the other volumes in the series, the introductory section describes the properties of the function, the composition of the tables, and methods of interpolation.

Stresses in Aircraft and Shell Structures. By Paul Kuhn. 1956, McGraw-Hill Book Company, Inc., New York, N. Y. 435 p., $6 \times 9^1/_4$ in., bound. $14. This presentation of methods for the analysis of shell structures deals with such problems as stresses due to bending of box beams, stresses due to torsion with restrained warping, stress around cutouts, and stresses in plane-web and curved-web systems under diagonal tension. Test methods for demonstrating the accuracy of the methods discussed are dealt with in the last quarter of the book.

Surface Treatment and Finishing of Aluminum and Its Alloys. By S. Wernick, and R. Pinner. 1956, Robert Draper, Ltd., Middlesex, England. 580 p., $5^1/_2 \times 8^5/_8$ in., bound. $12. Of value to engineers, designers, and research workers, this comprehensive treatment of all the available processes covers mechanical surface treatments and finishes; electrolytic and chemical polishing; chemical cleaning and pretreatment; conversion coatings; anodizing; coloring anodic oxide coatings; electrodeposition; organic finishing; vitreous enamelling; and metal spraying. Discussions of the theory as well as the practical aspects of most of the processes are included. An appendix gives the composition and properties of major British and American aluminum alloys.

Surveys in Mechanics. (The G. I. Taylor 70th Anniversary Volume). Edited by G. K. Batchelor and R. M. Davies. 1956, Cambridge University Press, London, England. 475 p., $5^{1}/_{4} \times 8^{5}/_{8}$ in., bound. $9.50. Ten substantial papers and a biographical note on Sir Geoffrey Taylor comprise this anniversary volume. Each of the papers is an authoritative review, with references, of the present state of knowledge in some field of mechanics in which Sir Geoffrey was interested. Written both for specialists and nonspecialists, the papers cover the following subjects: quasi-static plastic deformation in metals; dislocations in crystalline solids; stress waves in solids; rotating fluids; drops and bubbles; wave generation by wind; viscosity effects in sound waves; turbulent diffusion; atmospheric turbulence; and the mechanics of sailing ships and yachts.

The Technical Institute. By L. F. Smith and L. Lipsett. 1956, McGraw-Hill Book Company, New York, N. Y. 319 p., $5^{3}/_{8} \times 8^{1}/_{4}$ in., bound. $5. The first part of this book deals with the history and present status of the technical institute in the United States, giving data on enrollments, types of curricula, and careers of graduates. The second part, a discussion of problems in the organization and administration of a technical institute, covers such subjects as surveying the demand for technicians, planning a curriculum, recruiting students, and co-operative education programs.

Theory of Combustion Instability in Liquid Propellant Rocket Motors. By Luigi Crocco and Sin-I. Cheng. Agardograph No. 8, 1956. Butterworths, London, England. Available in the U. S. from Interscience Publishers, New York, N. Y. 200 p., 6 × 10 in., bound. $5.25. The first chapter of this monograph deals briefly with the mechanisms responsible for detrimental and nondetrimental types of rough combustion. The remaining three chapters are devoted to the theoretical analysis of chugging (low-frequency instability) and of screaming (longitudinal high-frequency instability), and to a comparison of the theoretical results with published experimental findings.

Werkzeugnormen: Maschinenwerkzeuge aus Schnellarbeitsstahl und Werkzeugstahl. Second edition, 1955. Edited by Deutscher Normenausschuss. Available from Beuth-Vertrieb, Berlin, Germany. 207 p., $5^{1}/_{1} \times 8^{1}/_{1}$ in., paper. 15 DM. The German standards covering machine tools are grouped in this publication for ready reference under the headings: reamers, milling cutters, twist drills, countersinks, cutting-off tools, screw-cutting tools, and gear cutters. Indexed by subject and standard designation.

ASME Boiler and Pressure Vessel Code

Interpretations

The Boiler and Pressure Vessel Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in Mechanical Engineering.

(The following Case Interpretations were formulated at the Committee meeting April 27, 1956, and approved by the Board on July 3, 1956.)

Case No. 1215

(Special Ruling)

Inquiry: Tables 2 to 15 of ASA B16.5-1953 and Notes on Page 11 of this Standard pertaining to these Tables are accepted by Sections I and VIII of the Code for ratings of steel pipe flanges and flanged fittings. MSS-SP-47 (1955) stipulates certain dimensions for gaskets of different types which warrant Class A Ratings under Note (1)(d) of these Tables. May the data presented in MSS-SP-47 (1955) be used in Code construction?

Reply: It is the opinion of the Committee that the data presented in MSS-SP-47 (1955) meets the intent of the Code as they apply to Note (1)(d) to Tables 2 to 15 of ASA B16.5-1953.

Case No. 1222

(Special Ruling)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the applicable rules of Section VIII meet the intent of the Code if the base material is an aluminum-magnesium-manganese alloy conforming to alloy GM40A, ASTM Specification B-178-55T?

Reply: It is the opinion of the Committee that the aluminum-magnesium-manganese alloy described in the Inquiry may be used for the construction of unfired pressure vessels according to the applicable rules of Section VIII subject to the following conditions:

(1) The welding requirements and applicable paragraphs of Section IX, apply with the following additional requirements:

> (a) The base material is assigned to classification P-22;
>
> (b) The filler material is from classification F-22;
>
> (c) For qualification of welders, welding operators and procedures, the strength of the reduced section tensile specimen shall be not less than 35000 psi.

(2) The following maximum allowable stress values are used in applying the design rules where reference is made to Table UNF-23:

	For Metal Temperature Not Exceeding Deg F	
Condition	**100**	**150**
Annealed	8700	8700
H112	8700	8700
H32	10000	9900
H34	11000	10800

(3) For welded joints, the allowable stress values for annealed material are used.

(4) In view of the fact that this alloy does not undergo a marked drop in impact resistance at subzero temperatures, no additional requirements are specified for temperatures down to −325 F (see Par. UNF-65).

(5) The joint efficiency factors, inspection, and testing comply with the applicable paragraphs of Section VIII.

(6) Thermal stress-relieving is not mandatory (see Par. UNF-56).

(7) In addition to the material described herein, any of the aluminum alloy materials for which allowable stress values for welded construction are given in Table UNF-23 may be used for appurtenances and other attachments. These parts and their connections shall be designed in accordance with the lower of the stress values in Par. (2) above and the applicable values in Table UNF-23. The welding process for these connections shall be qualified in accordance with the applicable rules of Section IX, except that the strength of the reduced-section tensile specimen shall be not less than the lower of the specified tensile strengths of

the two materials in the annealed temper.

Annulment of Cases

The following Cases are to be annulled:

CASE NOS.	REASONS FOR ANNULMENT
1167	Stress values now included in Table UNF-23, Section VIII.
1191	Fig. UNF-28.14 now included in Section VIII.
1195	Fig. UNF-28.10 (revised) now included in Section VIII.
1197	Stress values now included in Table UNF-23, Section VIII.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code...

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1956

PAR. P-1(b) Revise the first sentence to read:

Pressure parts such as pipe fittings, valves, flanges, nozzles, welding necks, welding caps, manhole frames and covers, and casings of pumps which are part of a boiler circulation system, shall be made of materials listed in Section II of the Code or in an accepted standard (such as ASA) covering the particular type of pressure part.

PAR. P-22(a) Revise the last paragraph to read:

Where the outside diameter of a circular boiler pressure part exceeds 5 in., the minimum thickness shall be determined by the formulas in Par. P-23.

PAR. P-23 Revise heading and first paragraph of sub-paragraph (*a*) to read:

P-23 *Cylinders (Up to and Including 24 in. O.D.) Under Internal Pressure* (a) The maximum allowable working pressure or minimum thickness of pipe, drums and headers up to 24 in. in outside diameter for temperatures not exceeding those given for the various materials listed in Table P-7, shall be determined by the formulas:

$$t_m = \frac{PD}{2SE + 2yP} + C$$

$$P = \frac{SE}{\frac{1}{2}\left(\frac{D}{t_m - C}\right) - y}$$

where, t_m = minimum thickness of wall in inches.[1] The minimum thickness used in the formula shall in no case be more than the minimum thickness resulting from the application of the tolerances given in the Code specification for the material to be used, including tube material which is to be used for piping;

P = maximum internal service pressure, pounds per square inch, at the operating metal temperature for which the value of S is taken from Table P-7.[2] The value of P in the formula shall not be taken at less than 100 for any condition of service or material. (For feed and blow-off piping see P-24, P-25, and P-26);

D = outside diameter of cylinder, inch; (for $D > 24''$, use formulas in Par. P-180);

E = efficiency of longitudinal welded joint or of ligaments between openings; whichever is lower:

E = 0.95 for fusion welded joints;
E = 1.0 for seamless cylinders;
E = from Par. 192 and Par. 193, for ligaments between openings;

S = allowable stress due to internal pressure at the operating temperature in material, pounds per square inch, from Table P-7;

C = allowance for threading, mechanical strength, and/or corrosion, inches;

y = a coefficient having values as follows:

	Temperature, Deg F					
	900 and below	**950**	**1000**	**1050**	**1100**	**1150 and above**
Ferritic steels	0.4	0.5	0.7	0.7	0.7	0.7
Austenitic steels	0.4	0.4	0.4	0.4	0.5	0.7

NOTE: Values of y between temperatures listed may be determined by interpolation.

Also number second, third, fourth, and fifth paragraphs of P-23(a) on Page 8 as: P-23(a)(1), P-23(a)(2), P-23(a)(3), and P-23(a)(4).

PAR. P-23(c) Delete Par. P-23(c) and replace by:

(c) The maximum allowable working pressure for parts of boilers of cylindrical cross-section designed for temperatures up to that of saturated steam at critical pressure (705.4 F) and having a thickness exceeding one-half the inside radius shall be determined by the formulas in Par. A-125.

PAR. P-23(g) Revise to read:

(g) Stresses due to hydrostatic head shall be taken into account in determining the minimum thickness required. Additional stresses imposed by effects other than working pressure or static head which increase the average stress by more than 10 per cent of the allowable working stress shall also be taken into account. These effects include the weight of the cylinder and its contents, and method of support.

PAR. P-23(k) Add new subparagraph (k):

(k) Inside backing strips when used at longitudinal welded joints shall be removed and the weld surface prepared in accordance with Par. P-102(h)(2)(a). Inside backing rings may remain at circumferential welded seams of cylinders provided such construction complies with the requirements of Par. P-112.

For constructions operating in the range where creep and stress rupture strength govern the selection of stresses, all weld reinforcement should be removed.

PAR. P-180(a) Revise to read:

P-180 *Cylinders (Larger Than 24 In. O.D.) Under Internal Pressure* (*a*) The maximum allowable working pressure for parts of boilers of cylindrical cross-section shall be determined by the strength of the weakest course computed from the thickness, the efficiency of the longitudinal joint or the ligaments between openings (whichever is the least), the inside radius and the maximum allowable unit working stress, using formulas under (b), (c) or (d).

PAR. P-180(c) Revise to read:

(c) Where the thickness exceeds $^1/_2$ in., for cylinders of seamless or fusion welded construction, and which do not require staying, the following formulas shall be used:

$$P = \frac{SE(t - 0.1)}{R + (1 - y)(t - 0.1)}$$

$$t = \frac{PR}{SE - (1 - y)P} + 0.1$$

where symbols have the same values as in (b), and y has the following values:

		900 F and below	950 F	1000 F	1050 F	1100 F	1150 F and above
Ferritic steels	$y = 0.4$		0.5	0.7	0.7	0.7	0.7
Austenitic steels	$y = 0.4$		0.4	0.4	0.4	0.5	0.7

Note: Values of y between temperatures listed may be determined by interpolation.

Stresses due to hydrostatic head shall be taken into account in determining the minimum thickness required. Additional stresses imposed by effects other than working pressure or static head which increase the average stress by more than 10 per cent of the allowable working stress shall also be taken into account. These effects include the weight of the cylinder and its contents, and method of support.

Inside backing strips when used at longitudinal welded joints shall be removed and the weld surface prepared in accordance with Par. P-102(h)(2)(a). Inside backing rings may remain at circumferential welded seams of cylinders provided such construction complies with the requirements of Par. P-112.

For constructions operating in the range where creep and stress rupture strength govern the selection of stresses, all weld reinforcement should be removed.

Par. P-180(d) Revise to read:

(d) The maximum allowable working pressure for parts of boilers of cylindrical cross-section designed for temperatures up to that of saturated steam at critical pressure (705.4 F) and having a thickness exceeding one-half the inside radius shall be determined by the formulas in Par. A-125.

Par. P-180(e) Delete.

Par. P-299(a) Revise sixth paragraph to read:

Valves, other boiler appurtenances such as water columns, and casings of pumps which are part of a boiler circulation system, may have fusion-welded joints other than longitudinal, complying with the requirements of Par. P-112 except that inspection of these joints is not required. The manufacturer shall furnish, if requested, a statement certifying that these requirements have been met.

Unfired Pressure Vessels, 1956

Par. UG-14 Add as a new paragraph:

UG-14 *Rods and Bars* Rod and bar stock may be used in pressure vessel construction for pressure parts such as flange rings, stiffening rings, frames for reinforced openings, stays and staybolts, and similar parts. Rod and bar materials shall conform to the requirements for bars, bolting, or rivets in the applicable part of Subsection C.

Par. UG-32(1) Revise to read:

(1) Ellipsoidal, torispherical, and toriconical heads, concave to pressure, intended for welded attachment, shall have a skirt length sufficient to meet the requirements of Fig. UW-13, for the respective types of joint shown therein.

Par. UG-32(m) Revise to read:

(m) Heads concave to pressure, intended for attachment by riveting or brazing, shall have a skirt length sufficient to meet the requirements for circumferential joints in Part UR and Part UB, respectively.

Par. UG-32(o) Revise to read:

(o) Dished heads of full hemispherical shape, concave to pressure, intended for butt-welded attachment, need not have an integral skirt, but where one is provided, the thickness of the skirt shall be at least that required for a seamless shell of the same diameter.

Par. UW-13(a) Revise to read:

Ellipsoidal, torispherical and other types of formed heads, concave or convex to the pressure, shall have a skirt length not less than that shown in Fig. UW-13. Heads that are fitted inside or over a shell shall have a driving fit before welding.

Fig. UW-13 Revise as follows:

Sketch (a) Dimension length of skirt in both parts of sketch as follows:

Min. $3t_h + 1/2''$, but not less than $1''$.

Sketch (b) Change lowermost dimension to read:

Min. $4t_s$ or $4t_h$, whichever is less.

Sketch (c). Dimension length of skirt same as for Sketch (a).

Sketch (d) An additional sketch is to be prepared in which the head thickness is substantially equal to the shell thickness with a caption to read: "When t_h is equal to or less than 1.25 t_s." Skirt dimension is to read: "Skirt optional; see Par. UG-32(o) for hemispherical heads."

In present Sketch (d) add caption to read: "When t_h exceeds 1.25 t_s." Change skirt dimension to read: "Min. 3 t_h, but need not exceed $1\,1/2''$, for all except hemispherical heads. For hemispherical heads, see Par. UG-32(o)."

Par. UCS-12 Add as a new paragraph to read:

UCS-12 *Rods and Bars* (a) Approved specifications for bar materials of carbon steel are given in Table UCS-23, together with a tabulation of allowable stress values at different temperatures.

(b) Bolt and rivet materials as described in Par. UCS-10 may be used as bar materials.

(c) Parts made from bars, on which welding is done, shall be of material for which a P-Number for procedure qualification is given in Section IX, Table Q-11.1 of the Code (see Par. UW-5).

Table UCS-23 Add the accompanying stress values, for SA-31 and SA-306.

Par. UA-805(a) Revise to read:

(a) When the contents of a vessel are known or expected to be corrosive, the maximum period between inspections should not exceed one-half of the estimated remaining safe operating life of the vessel, or five years, whichever is less.

In cases where part or all of the vessel wall has a protective lining, the frequency of inspection for the portions of the vessel so protected should be determined from a consideration of previous records for the lining during similar operations and the corrosion allowance for the protected metal if there is any likelihood that the lining will fail; but

Additions to Table UCS-23

					For Metal Temperatures Not Exceeding Deg F							
Mat'l Spec No.	Grade	Nom comp	Spec min tensile	Notes	—20 to 650	700	750	800	850	900	950	1000
BARS & RIVET STEEL												
Carbon Steels												
SA-31	A	..	45000	(4)	11250	11000	10250	9000	7750	6500	..	..
SA-31	B	..	58000	(4)	14500	13900	12600	10550	8550	6500	..	..
SA-306	45	..	45000	(4)	11250	11000	10250	9000	7750	6500	..	..
SA-306	50	..	50000	(4)	12500	12100	11150	9600	8050	6500	..	..
SA-306	55	..	55000	(4)	13750	13250	12050	10200	8350	6500	..	..
SA-306	60	..	60000	(4)	15000	14350	12950	10800	8650	6500	..	..

otherwise the maximum periods between inspections on such vessels should conform to the foregoing provisions.

When a vessel has two zones of considerable extent whose net discarding thicknesses, corrosion allowances, or corrosion rates differ so much that the foregoing provisions give important differences in maximum periods permissible between inspections for the respective zones (as, for example, the upper and lower portions of some fractionating towers), the periods between inspections may be established individually for each of the zones on the basis of the conditions applicable thereto, instead of being established for the entire vessel on the basis of the zone requiring the more frequent inspection.

Where reference is made, in the above provisions, to the "net discarding thickness" for a vessel, it shall be understood to mean: (1) the net wall thickness, exclusive of any corrosion allowance, required by the safety-valve setting and operating temperature for the service in which the vessel is being used; or (2) the minimum thickness permitted by UCS-16(b) or other similar applicable provisions of the Code, whichever is greater.

Par. UA-805(b) Revise to read:

(b) When the contents are known to be non-corrosive or corrosion-inhibited and practically no external corrosion is expected, the vessel need not be inspected as long as it remains in the same service but the metal surface of the vessel should be examined on either the outside or inside at least every five years.

Par. UA-805(c) Revise to read:

(c) In addition, all vessels above ground should be given a visual external examination at least once a year, preferably while in operation, to determine the readily apparent general condition of the vessel and its supports and insulation.

Par. UA-805(d) Reletter as Par. UA-805(e).

Par. UA-805(d) Add new subparagraph (d):

(d) The safety- and-relief-valve equipment should be inspected and tested at intervals as necessary to maintain the equipment in satisfactory operating condition. The intervals between inspection should be determined by experience in the particular service concerned. Other pressure-relieving devices, such as rupture disks, should be given a thorough examination at the same interval.

Par. UA-806(a)(4) Revise to read:

Any other suitable method that will not affect the safety of the vessel may be used providing it will assure minimum thicknesses accurate to within $^{1}/_{32}$ in. or 5 per cent of the thickness whichever is greater.

Par. UA-808(a) Revise to read:

(a) The parts of a vessel which should be inspected most carefully depend upon the type of vessel and the operating conditions to which it is subjected. The inspector should be familiar with the operating conditions of the vessel and with the causes and character of defects and deterioration that may result therefrom.

(b) Among the many ways of inspecting a vessel for defects, careful visual examination is by far the most important and most universally applicable. Other means that may be very useful from time to time include magnetic particle inspection (for cracks and other elongated discontinuities), fluorescent penetrants (for disclosing porosity, pin holes, etc., which extend to the surface of the material, and for outlining other surface manifestations expecially in non-magnetic materials), hammer testing, pressure testing, exploratory chipping, etc. All of these methods should be considered as auxiliary to careful visual examination, and the extent to which one or more of them should be used in any given case can be determined only by the exercise of mature judgment based upon the details of circumstances encountered. Adequate surface preparation is frequently of paramount importance to proper visual examination and to the satisfactory application of any auxiliary procedure such as those mentioned above. The extent to which special surface preparation may be required is dependent upon the individual circumstances involved, but may require wire brushing, sand blasting, chipping, or grinding, or a combination of these operations in addition to routine cleaning.

(c) If it is found that external or internal coverings such as insulation, refractory protective linings, corrosion-resistant linings, etc., where they exist, are in good condition and there is no reason to suspect any unsafe conditions behind them, it is not necessary to remove them for inspection of the vessel; however, in such cases it may sometimes be advisable to remove small portions of the coverings in order to investigate their condition and effectiveness and the condition of the metal back of them. Where operating deposits, such as coke, are normally permitted to remain on a vessel surface, it is particularly important to determine whether such deposits adequately protect the vessel surface from deterioration and this may require thorough removal of the deposit in selected critical areas for spot check examination. Where vessels are equipped with removable internals, these internals need not be completely removed provided reasonable assurance exists that deterioration in regions rendered inaccessible by them is not occurring to an extent that might constitute a hazard or to an extent beyond that found in more readily accessible parts of the vessel.

(d) The items that should normally be examined during an inspection, subject in each case to the provisions of (c) above, and various suggestions concerning some of the things to be looked for, or procedures that may be used, on them are as follows:

(1) *Shells and Heads*—Examine surfaces carefully for possible cracks, blisters, bulges, and other evidences of deterioration giving particular attention to the knuckle regions of the heads. If evidence of distortion is found, it may be advisable to make a detailed check of the actual contour against the design shape even though this may require removal of insulation or internal protective linings.

(2) *Joints*—Examine inner and outer surfaces of welded joints carefully for possible cracks and for other defects such as may have been uncovered by the progress of corrosion. Magnetic particle inspection is suggested as a useful means for doing this either throughout the lengths of the welds or as a supplement to visual inspection on selected lengths which may appear to need more than a visual inspection. Examine riveted joints inside and outside of the vessel for the condition of the rivet heads, butt straps, and plates, and for the condition of the calked edges.

(3) *Manways, Nozzles, and Other Openings*—Examine the surfaces of all manways, nozzles, and other openings carefully for distortion, cracks, and other defects giving particular attention to all welding or riveting used for attaching such parts and their reinforcements. If any question exists as to the condition of any threaded connections, the threaded parts should be disassembled to permit a careful check of the number of threads that remain effective and in good condition. Examine accessible flange faces for distortion and for the condition of gasket seating surfaces.

The inspection items given above are not presumed to be complete for every vessel, but include those features common to most vessels and in general those of greatest importance. Inspectors must supplement this list with any additional items necessary for the particular vessel or vessels involved.

ASME News

With Notes on Society Activities and Events

E. S. Newman, *News Editor*

View shows downtown Denver, Colo., where 1956 ASME Fall Meeting will be held at Cosmopolitan Hotel, Sept. 10–12. Civic Center, *left,* is flanked by the State Capitol and the Denver City and County Building. At *right center* one sees the new 23-story "Mile High Center."

1956 ASME Fall Meeting to Be Held September 10–12 Amid Colorado's Magnificent Scenery

President Barker to discuss long and short-term attacks on the engineer and scientist shortages

The 1956 Fall Meeting of The American Society of Mechanical Engineers will be held at the Cosmopolitan Hotel, Denver, Colo., Sept. 10–12, 1956.

The technical program, comprising more than 30 papers, represents the joint efforts of the following Professional Divisions of the Society: Gas Turbine Power, Machine Design, Power, Hydraulic, Production Engineering, Process Industries, Management, and Heat Transfer. The Education Committee, in conjunction with the National Junior Committee, has prepared a two-session program, the first devoted to the mechanical engineer in the chemical, rubber, and petroleum industries and the second, in the form of a panel discussion, which will take up the question, "Are Engineers Underpaid?"

Shortage of Engineers

Joseph W. Barker, ASME President, has chosen "Long and Short-Term Attacks on Engineer and Scientist Shortages" as his topic for discussion at the President's Luncheon. The banquet, to be held Tuesday, September 11, will have Tom Collins, publicity director, National Bank and Trust Company, Kansas City, Mo., as principal speaker. His topic is "Price Tags of Progress."

Three interesting inspection trips have been planned which include the cryogenic laboratory of the National Bureau of Standards, Bureau of Reclamation Laboratory, and a scenic flight over colorful Colorado. To take full advantage of the magnificent scenery in and around Denver, several bus trips have been arranged to Denver Mountain Parks, Prospectors Central City tour, Mt. Evans-Central City tour, Denver City tour, Pikes Peak tour, and a scenic circle tour. These trips are available every day and may be selected to suit individual schedules.

The tentative program for the meeting follows:

Orders for Technical Papers

ONLY copies of *numbered* ASME papers will be available. Some of these papers may not be available in time to permit your receiving them in advance of the meeting. Your order will be mailed only when the complete order can be filled unless you request that all papers available ten days before the meeting be mailed at that time. Please order only by paper *number;* otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the meeting.

Copies of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons in lots of ten are $2 for members, $4 for nonmembers.

Copies of unnumbered papers, listed in the program, *are not available* because the review of these manuscripts had not been completed when the program went to press. The author's name and paper number will appear with paper title in the final program (final program available only at meeting) as well as the issue of MECHANICAL ENGINEERING containing an account of the meeting, if the paper has been recommended for publication in pamphlet form.

MONDAY, SEPTEMBER 10

8:00 a.m.

Registration

9:30 a.m.

Gas Turbine Power

An Industrial Plant Installation of a Gas Turbine to Generate Power and Process Steam[1]

A 5000-Kw Dual Fuel Gas Turbine for Industrial Power[1]

9:30 a.m.

Machine Design (I)

Kinematic Analysis and Synthesis Using Collineation Axis Equations, by *W. J. Carter*, University of Texas (Paper No. 56—F-4)

On the Adiabatic Couette Flow of a Compressible Fluid[1]

Tables of Functions of Short Cylindrical Shells, by *R. B. McCalley, Jr.*, General Electric Co., and *R. G. Kelly*, The Johns Hopkins University (Paper No. 56—F-5)

12:15 p.m.

President's Luncheon

Toastmaster: *Clifford H. Shumaker*, Vice-President, Region VIII; chairman, Department of Industrial Engineering, Southern Methodist University, Dallas, Texas

Welcome: *The Hon. Will F. Nicholson*, Mayor of the City of Denver

Speaker: *Joseph W. Barker*, ASME President

Subject: **Long and Short-Term Attacks on Engineer and Scientist Shortages**

2:30 p.m.

Machine Design (II)

Curved Beams Having Eccentric Boundaries, by *J. P. Vidosic*, Georgia Institute of Technology; *F. J. Bogardus*, Purdue University; and *J. C. Durden*, Georgia Institute of Technology (Paper No. 56—F-1)

Calculating the Size of Flywheel Required for a Synchronous Motor Driven Reciprocating Compressor[1]

Graphical Shoe-Brake Analysis, by *G. A. G. Fazekas*, Polytechnic Institute of Brooklyn (Paper No. 56—F-3)

2:30 p.m.

Power (I)

Power From Solar Energy—Some Fundamental Considerations. by *J. I. Yellott*, Association for Applied Solar Energy, Phoenix, Ariz. (Paper No. 56—F-15)

Solar Furnaces for High-Temperature Research, by *Guy Benveniste* and *N. K. Hiester*, Stanford Research Institute (Paper No. 56—F-7)

2:30 p.m.

Education (I)—Junior (I)

The Role of the Mechanical Engineer in the Chemical Industry[1]

The Role of Mechanical Engineers in the Rubber Industry[1]

The Role of Mechanical Engineers in the Petroleum Industry[1]

8:00 p.m.

Junior (II)—Education (II)

***Panel Discussion:* "*Are Engineers Underpaid?*"**

TUESDAY, SEPTEMBER 11

8:00 a.m.

Registration

9:30 a.m.

Power (II)

Boiler Cleaning—Methods and Controls, by *L. B. Schueler*, Diamond Power Specialty Corp. (Paper No. 56—F-13)

Instruments and Control—Key to Economical Performance of Steam-Power Plants, by *P. S. Dickey*, Bailey Meter Co. (Paper No. 56—F-14)

9:30 a.m.

Hydraulic

Cavitation Characteristics of Gate Valves and Globe Valves Used as Flow Regulators Under Heads Up to About 125 Ft, by *J. W. Ball*, U. S. Bureau of Reclamation (Paper No. 56—F-10)

Development of Hydraulic Operation for Gates and Valves, by *W. H. Kohler*, U.S. Bureau of Reclamation (Paper No. 56—F-8)

9:30 a.m.

Production Engineering (I)

Measurement and Mechanization of Production-Control Scheduling, by *H. Ford Dickie*, General Electric Co. (Paper No. 56—F-2)

Computer Simulation of Job-Lot Production[1]

2:30 p.m.

Power (III)

Approximating Partial-Load Performance of Large Reheat Turbine-Generator Units[1]

Utilization of Lignite[1]

2:30 p.m.

Production Engineering (II)

Economic-Lot Sizes for Some Elementary Inventory Systems[1]

Economic-Lot Size Formulas in Manufacturing

Registration Schedule

Sunday, September 9, 3:00 p.m. to 5:00 p.m.

Monday, September 10, 8:00 a.m. to 8:00 p.m.

Tuesday, September 11, 8:00 a.m. to 3:00 p.m.

Wednesday, September 12, 8:00 a.m. to 12:00 noon

2:30 p.m.

Process Industries

The Nanta Mixer—A New Solid Blender and Its Application in Feed Preparation[1]

A Preliminary Analysis of a Turning Jet[1]

6:00 p.m.

Social Hour

7:00 p.m.

Banquet

Toastmaster: *Clarence L. Eckel*, Dean, College of Engineering, University of Colorado, Boulder, Colo.

Speaker: *Tom Collins*, Publicity Director, National Bank & Trust Company, Kansas City, Mo.

Subject: **Price Tags of Progress**

(Business Dress)

WEDNESDAY, SEPTEMBER 12

8:00 a.m.

Registration

9:30 a.m.

Management

Human Factors in Engineering Management, by *H. M. Miller, Jr.*, E. I. du Pont de Nemours & Co., Inc. (Paper No. 56—F-12)

Engineering Management in Reclamation[1]

9:30 a.m.

Heat Transfer

Turbulent Free Convection Heat-Transfer Rates in a Horizontal Pipe, by *J. P. Fraser* and *D. J. Oakley*, General Electric (Paper No. 56—F-6)

Mollier Diagrams for Water Near Bubble Point, by *André Van Haute* and *B. H. Sage*, California Institute of Technology (Paper No. 56—F-9)

Determination of Thermal Conductivities of Metals by Measuring Transient Temperatures in Semi-Infinite Solids, by *S. T. Hsu*, University of Dayton (Paper No. 56—F-11)

TRIPS AND EXCURSIONS

Wednesday, September 12

12:30 p.m.

National Bureau of Standards—Cryogenic Laboratory

The program provides for a 2-hour stopover on Wednesday afternoon at this new and modern laboratory at Boulder, Colo. Here are located a liquid hydrogen plant, a liquid nitrogen plant, and extensive facilities for development and evaluation of engineering materials for use at very low temperatures.

This trip is part of a 5-hour historical and pictorial trip which begins at the Cosmopolitan Hotel at 12:30 p.m. The trip continues westward, skirting Golden and the Colorado School of Mines, and travels up scenic Clear Creek Canyon to historic Central City. Thirty minutes will be spent in this "Richest Square Mile on Earth" to view the Teller House, whose threshold was paved with silver bricks to welcome General U. S. Grant; and other buildings. The trip continues northward on the Peak to Peak Hiway with many majestic views of the Continental Divide at close range; entering attractive granite-lined Boulder Canyon at Nederland and emerging at the City of Boulder. The University of Colorado with its beautiful Italian Renaissance buildings of native pink sandstone is in Boulder. The Cryogenic Laboratory is next, arriving about 4:00 p.m. where a 2-hour stopover is made, following which two hours is taken for dinner in Boulder followed by the trip back to Denver over the broad 4-lane Turnpike.

Trip made by Scenic View Buses leaving Cosmopolitan Hotel at 12:30 p.m. including box lunch eaten en route and returning at about 9:30 p.m.

12:30 p.m.

Bureau of Reclamation Laboratory

This trip includes a 2-hour stopover and tour through the modern and up-to-date Engineering Laboratories covering several acres of space where model studies are made of hydraulic structures and equipment, and where soils, concrete, and other materials are tested and evaluated to assure safe and efficient operation of Bureau projects at minimum costs. A 5-hour photogenic trip continues into the beautiful foothills of the rugged Rocky Mountains, including a short stop

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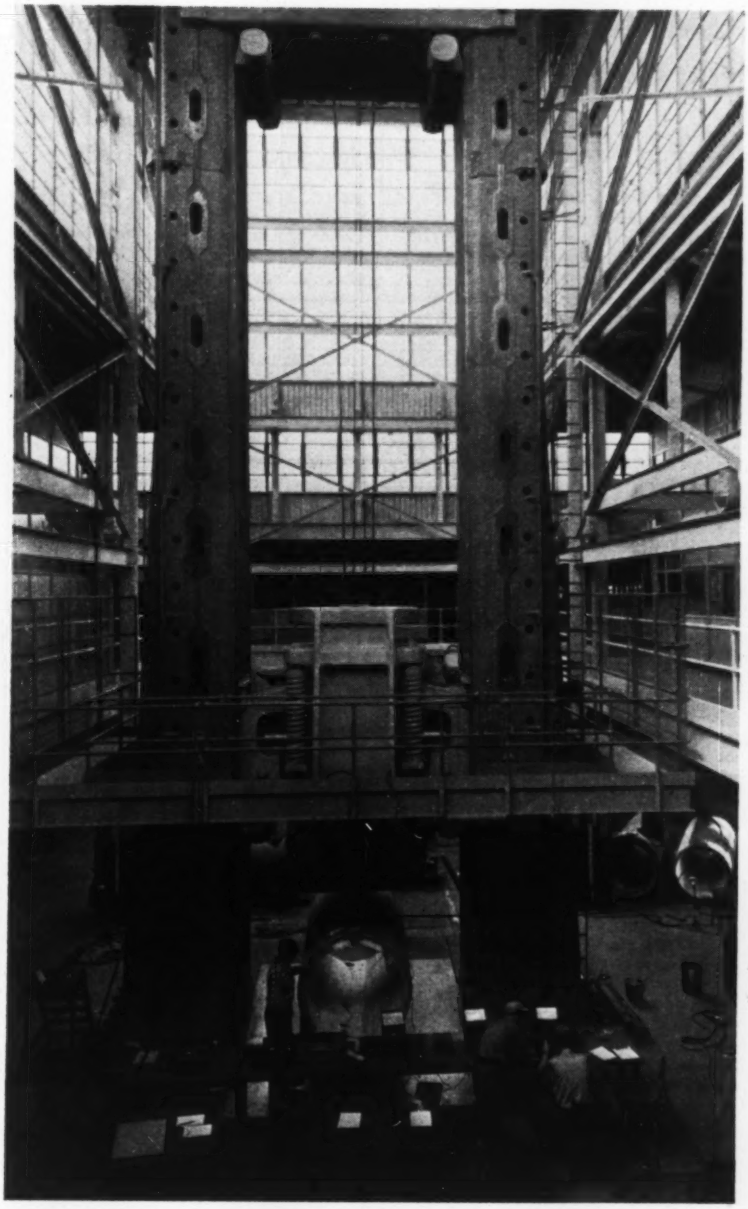
[1] Paper not available—see box on this page.



During the inspection trip through the Bureau of Reclamation Laboratory scheduled for the 1956 ASME Fall Meeting in Denver, Colo., visitors will see a 5-million-lb universal testing machine, *above*, used in full-scale testing of a variety of materials and structural components

in the Garden of the Red Rocks where exotic shapes and unusual formations of sedimentary Dakota sandstone have provided a natural amphitheatre and other interesting sights. Bear Creek Canyon, cut through metamorphic rocks, lined with beautiful summer homes and abundant Blue Spruce trees, is ascended to the quaint mountain village of Evergreen nestled near Evergreen Lake. A 2-hour stopover for dinner is made at Hiway US 40 junction where a view of the granite-formed Continental Divide is had, after which the trip continues on to Lookout Mountain, down the Lariat Trail where the nighttime view down on Golden and Denver is impressive. Dinner is optional.

Trip is made by Scenic View Buses, leaving Cosmopolitan Hotel at 12:30 p.m., including box lunch eaten en route and returning at about 9:30 p.m.

1:30 p.m.

Scenic Flight Over "Colorful Colorado"

Arrangements made with Western Airlines will provide an enjoyable one and one half hour flight over the eastern slope of the Rockies. This nonstop flight will leave Denver airport at 1:30 p.m. and fly to Colorado Springs, where such places of interest as the Air Academy site, Pikes Peak, and the Broadmoor Hotel will be seen. Passing Canon City and the Royal Gorge, site of the world's highest suspension bridge, the flight will turn north to the exquisite scenery of the Rocky Mountain National Park and Big Thompson Canyon, returning via Boulder—home of the University of Colorado.

Scenic View Bus Trips Available for Sunday, September 9, or on Other Days

	Leave	*Return*
Denver Mountain Parks—61 miles	9:15 a.m. 2:15 p.m.	1:15 p.m. 6:15 p.m.
Prospectors Central City Tour—86 miles	3:00 p.m.	9:00 p.m.
Mount Evans-Central City Tour—150 miles	9:00 a.m.	5:30 p.m.
Denver City Tour—23 miles	9:00 a.m. 11:00 a.m. 2:00 p.m. 4:00 p.m.	10:30 a.m. 12:30 p.m. 3:30 p.m. 5:30 p.m.
Pikes Peak Tour—223 miles	8:30 a.m.	6:30 p.m.
Scenic Circle Tour—100 miles	10:00 a.m. 1:30 p.m.	2:30 p.m. 7:00 p.m.

Tickets for any of the above trips will be arranged for by the Trips Committee at the Registration Desk.

WOMEN'S PROGRAM

Monday, September 10

8:00 a.m.	Registration
10:00 a.m.	Coffee at Ladies' Registration Booth
12:15 p.m.	President's Luncheon
2:30 p.m.	Trip to the Museum of Natural History located in City Park. It contains famous natural-habitat displays of animals, birds, and flowers; a notable collection of meteors and minerals, also reconstructed prehistoric animals.

Tuesday, September 11

8:00 a.m.	Registration
10:00 a.m.	Trip to Central City, historic gold-mining town, and the site of the famous Tabor Opera House.
12:00 noon	Luncheon at the "Old Fashioned Tea Room," followed by lecture on "Gold Rush Days in Colorado" by Mrs. Elwyn Arps, Colorado's Television Historian.
6:00 p.m.	Social Hour
7:00 p.m.	Banquet (informal)

Wednesday, September 12

8:00 a.m.	Registration
1:30 p.m.	Scenic Air Flight by Western Air Lines circling Colorado Springs, Pikes Peak and Royal Gorge, then turning north to the Rocky Mountain National Park, Big Thompson Canyon and returning to Denver via Boulder. Flight time approximately one and one half hours.

Either of the two inspection trips scheduled for the ASME members and guests would also be enjoyed by the women, although the trip to the Cryogenic Laboratory would duplicate in part the Central City trip scheduled for Tuesday.

ASME Plans Active Role in Second Nuclear Engineering Congress

The Second EJC Nuclear Engineering and Science Congress and accompanying Atomic Exposition will be held early in 1957 in Philadelphia, Pa. Like the first Congress, which was held in December, 1955, in Cleveland, Ohio, the 1957 event will be co-ordinated by Engineers Joint Council. Both the technical sessions and over-all Congress meetings, as well as the Atomic Exposition, will be held in the Convention Hall, March 11 through March 15, 1957.

The American Society of Mechanical Engineers joins with 18 other major engineering and scientific societies who already have indicated they plan to participate in the congress. An even larger group of engineers and scientists from industry, business, education, and government is expected to assemble in Philadelphia than attended the first congress. Also it is expected that the Atomic Exposition, which will display the latest developments in the application of nuclear energy, will draw a greater audience than the 13,000 who saw the Cleveland exhibits. There will be a greater number of exhibitors in the Exposition, reflecting the additional enterprise in nuclear energy and allied fields which has come into being in the 14 months since the first congress.

Walter G. Whitman, who was chairman of the United States Delegation to the 1955 Geneva Conference on Atomic Energy and head of chemical engineering at The Massachusetts Institute of Technology, has been named chairman of the General Committee for the Congress. Chairman of the Program Committee is Bruce R. Prentice, Mem. ASME, of the General Electric Company, Schenectady, N. Y., and a member of the EJC Panel on Atomic Energy.

ASME members who are planning to present papers at this congress are urged to advise R. W. Hartwell, ASME program chairman, by September 1, 1956. Address communications to: Mr. R. W. Hartwell, Department Director, The Detroit Edison Company, 2000 Second Avenue, Detroit 26, Mich.

ISA-IRD Conference and Show at Coliseum in New York

During the week of September 17, at the New York Coliseum, the Instruments and Regulators Division of The American Society of Mechanical Engineers will join with the Instruments Society of America in the 11th Annual International Instrument Automation Conference and Show.

The ASME session on Monday afternoon, September 17, consists of the following papers:

The Effect of a Logarithmic Element in an Otherwise Linear Process-Control System, by *G. L. d'Ombrain* and *A. Rashwan*

An Analytical Study of Linearized Industrial Process Controllers, by *Nye* and *Paradise*

Application Limits and Accuracies of Control-Valve Flow Coefficient C, by *D. J. Lin* and *A. J. Hanssen*

The ASME session on Tuesday afternoon, September 18, will consist of these papers:

The Application of an Analog Computer to the Measurement of Process Dynamics, by *P. E. A. Cowley*

Criteria for Validity of Lumped Parameter Representation of Ducting Air-Flow Characteristics, by *Theodore R. Stalzer* and *George J. Fiedler*

The Instrument-Automation Show will be open all during the week of September 17, and plenty of time will be available for those attending the Conference to also attend the show.

ASME Heat Transfer Division Announces First National Conference in 1957

Applied Heat Transfer Conference, Aug. 11–15, 1957, at The Pennsylvania State University

The Heat Transfer Division and the Central Pennsylvania Section of The American Society of Mechanical Engineers with the co-operation of the College of Engineering and Architecture of the University of Pennsylvania, and the American Institute of Chemical Engineers as cosponsor, recently announced the first national conference on applied heat transfer to be held Aug. 11–15, 1957, at the Pennsylvania State University.

The theme of the conference will be Applied Heat Transfer and papers are being solicited which bear directly upon heat-transfer applications. Particularly sought are papers dealing with the design, construction, and use of heat exchangers, economic and practical problems associated with insulation, methods of instrumentation and tests, and the results of research which may be applied in industrial practice.

A special feature of the conference will be a dinner and ceremonies honoring William H. McAdams of the Massachusetts Institute of Technology on the occasion of his retirement from teaching. A special effort is being made to invite former students of Professor McAdams to be present at the ceremonies which the sponsors are arranging to honor his many contributions to the field of heat transmission.

The program is being arranged under the general direction of G. M. Dusinberre, a member of the Heat Transfer Division's Executive Committee, the Central Pennsylvania Section of the ASME, and of the faculty of the College of Engineering of the Pennsylvania State University.

Professor Dusinberre has announced that the deadline for the submission of papers for the conference is Jan. 1, 1957. The papers must be in the hands of the Papers Committee Chairman by this date. The Papers Committee Chairman is: H. A. Johnson, Department of Mechanical Engineering, University of California, Berkeley 4, Calif.

Members of the Central Pennsylvania Section are now arranging technical sessions and social events.

In connection with the Heat Transfer Conference there will be an exhibit of equipment and apparatus useful in industrial heat transfer. Manufacturers of equipment for the measurement, recording, control, and production of heat transfer and thermal processes are invited to exhibit their wares. The exhibits will be under the supervision of A. H. Zerban of the Hamilton-Standard Company, Windsor Locks, Conn.

It is believed that this conference stressing heat-transfer applications will attract between two hundred and five hundred engineers from all over the United States.

J. J. Jaklitsch, Jr., Named Acting Editor of "Mechanical Engineering"

J. J. Jaklitsch, Jr., who has been on the editorial staff of The American Society of Mechanical Engineers since November, 1945, was named acting editor of Mechanical Engineering. He succeeds George A. Stetson, editor since 1930, who continues with the Society as editor emeritus.

In his new post Mr. Jaklitsch inherits a 76-year-old publishing tradition which began with the birth of ASME in 1880 and includes a history of engineering progress during that period.

His work on "Briefing the Record" has made it one of the most popular sections of the magazine. His reponsibilities grew in step with his advancement to the post of associate editor; noteworthy has been his supervision of the redesigning of Mechanical Engineering to improve its attractiveness and to streamline the feature articles.

In addition to editing Mechanical Engineering, Mr. Jaklitsch will be responsible for other periodical publications of the Society, Transactions and *Journal of Applied Mechanics*, as well as individually published technical papers.

Prior to joining the ASME editorial staff, Mr. Jaklitsch was employed by the U. S. Army Ordnance Department, where he was engaged in both an engineering and editorial capacity on U. S. Army instruments ranging from simple "Bazooka" sights, telescopes, and telescopic mounts for guns and howitzers, and tank periscopes, to such complex electromechanical computing devices as are used for pointing and firing antiaircraft guns, gun-data computers, and other remote-control computing instruments.

Until Thomas Nelson and Sons ceased publication of "The American Year Book," he was a contributing editor. For the past several years he has been a contributing editor to "Collier's Year Book," published by P. F. Collier & Sons.

Mr. Jaklitsch, a New Yorker by birth, received a bachelor's degree in mechanical engineering from Pratt Institute, Brooklyn, N. Y., in 1940. He is a member of the Pratt Alumni Association.

He joined the ASME as a Junior Member in 1941 and was promoted to Member of the Society in 1950.

He also is a member of the Society of Business Magazine Editors, the New York Business Paper Editors, and The Engineers' Club of New York.

ASME Coming Events

Sept. 10–12
ASME Fall Meeting, Cosmopolitan Hotel, Denver, Colo.
(Final date for submitting papers was May 1, 1956)

Sept. 17–21
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Coliseum, New York, N. Y.
(Final date for submitting papers was May 1, 1956)

Sept. 23–26
ASME Petroleum-Mechanical Engineering Conference, Conrad Hilton Hotel, Dallas, Texas
(Final date for submitting papers was May 1, 1956)

Oct. 8–10
ASME-ASLE Third Lubrication Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.
(Final date for submitting papers was June 1, 1956)

Oct. 24–25
ASME-AIME Joint Fuels Conference, Sheraton Park Hotel, Washington, D. C.
(Final date for submitting papers was June 1, 1956)

Nov. 25–30
ASME Annual Meeting, Hotel Statler; National Power Show, Coliseum, New York, N. Y.
(Final date for submitting papers was July 1, 1956)

March 10–16, 1957
EJC Nuclear Engineering and Science Congress, Convention Hall, Philadelphia, Pa.
(Final date for submitting papers—Nov. 1, 1956)

March 18–21, 1957
ASME Gas Turbine Power Conference, Hotel Sheraton-Cadillac, Detroit, Mich.
(Final date for submitting papers—Nov. 1, 1956)

March 27–28, 1957
ASME Engineering Management Conference, Hotel William Penn, Pittsburgh, Pa.
(Final date for submitting papers—Nov. 1, 1956)

April 8–10, 1957
ASME Spring Meeting, Hotel Dinkler-Tutwiler, Birmingham, Ala.
(Final date for submitting papers—Dec. 1, 1956)

April 22–24, 1957
ASME Instruments and Regulators Conference, Northwestern University, Chicago, Ill.
(Final date for submitting papers—Dec. 1, 1956)

April 25–26, 1957
ASME Railroad Conference, Hotel Sheraton, Chicago, Ill.
(Final date for submitting papers—Dec. 1, 1956)

April 25–26, 1957
ASME Management-SAM Conference, Hotel Statler, New York, N. Y.
(Final date for submitting papers—Dec. 1, 1956)

May 19–23, 1957
ASME Oil & Gas Power Conference, Kentucky Hotel, Louisville, Ky.
(Final date for submitting papers—Jan. 1, 1957)

June 9–13, 1957
ASME Semi-Annual Meeting, Sheraton-Palace Hotel, San Francisco, Calif.
(Final date for submitting papers—Feb. 1, 1957)

Ohio Society to Honor Charles F. Kettering

Charles F. Kettering, inventor, engineer, organizer, and leader in industrial research, will celebrate his eightieth birthday on Aug. 29, 1956. In his honor the Ohio Society of New York will sponsor a dinner at the Hotel Statler, New York, N. Y., on Oct. 1, 1956.

Boss Ket, as he is affectionately called, is a Fellow ASME and was the recipient of the ASME Medal in 1940 and the Hoover Medal in 1955. For 27 years he was vice-president of General Motors Corporation and general manager of their Research Laboratories Division. Now retired, he serves as research consultant and director of the corporation.

In 1927 he founded the Charles F. Kettering Foundation and as chairman of its board of directors he directs researches in the natural sciences, including work on chlorophyll and photosynthesis, artificial fever therapy, and cancer. He is also a director of the Sloan-Kettering Institute for Cancer Research.

Dr. Kettering's activities have included the invention of automotive starting, lighting, and ignition systems, electrified cash registers, credit systems, and accounting machines. He originated and guided researches resulting in higher-octane gasolines, extraction of bromine from sea water, high-compression automobile engines, improved automobile finishes, nontoxic and noninflammable refrigerants, and improved diesel engines.

The Ohio Society desires a large attendance of Dr. Kettering's friends; for further information regarding the 80th birthday dinner, write to John Q. Jennings, chairman, Program Committee, Ohio Society of New York, care of Singer Manufacturing Company, 149 Broadway, New York 7, N. Y.

International Fatigue of Metals Conference in London, September 10–14

The International Conference on Fatigue of Metals, sponsored by The Institution of Mechanical Engineers with the co-operation of The American Society of Mechanical Engineers, will be held in London, England, from Sept. 10 to 14, 1956.

The program, in ten sessions, will later be presented during the 1956 Annual Meeting of The American Society of Mechanical Engineers from November 28 to 30.

The topics for discussion during the international conference include stress distribution, temperature frequency and environment, metallurgical aspects of fatigue, various basic studies, engineering and industrial significance of fatigue, and the final session will be set aside for reporters' summaries and closures.

Present plans are under way for inspection trips following the conference, from September 17 to 21, to centers in England and Scotland at which research on fatigue of metals and metal components is being conducted.

1956 ASME Petroleum Conference to Be Held in Dallas, Texas

This coming September, from the 23rd to the 26th, there is scheduled one of the largest Petroleum Divisional Conferences of The American Society of Mechanical Engineers on record. It will be held in Dallas, Texas, at the Hilton-Statler Hotel.

On Sunday afternoon, there will be registration for the early arrivals and a "Get Acquainted" Reception with refreshments and a showing of pictures of Dallas and Houston, all with the compliments of the North Texas Section.

The Petroleum Conference program will include 34 technical papers, and two panel sessions. Three simultaneous sessions are scheduled for each morning and afternoon of the Conference.

The Ladies' Committee has arranged an interesting program for visiting women deep in the heart of "giant" country.

The program in detail follows:

MONDAY, SEPTEMBER 24

9:00 a.m. — **Embassy East Room**

Refining (I)

Session 1—Economics

Chairman: *F. J. Feely, Jr.*, head, Engineering Design Division, Esso Research and Engineering Co., Linden, N. J.

Vice-Chairman: *John Colby*, senior engineer, works engineering department, Deerpark Plant, Diamond Alkali Corp., Houston, Texas

Operating Considerations in Application of Gas-Turbine-Driven Centrifugal Pipe-Line Compressors, by *A. L. Vaughan*, Northern Natural Gas Co., Omaha, Neb. (Paper No. 56—PET-13)

Practical Economics for Refinery Mechanical Engineers, by *T. S. Fennema*, Humble Oil & Refining Co., Baytown, Texas (Paper No. 56—PET-7)

9:00 a.m. — **Silver Room**

Production (I)—Manufacturers (I)

Session 2—Mechanical Properties of Rock

Chairman: *R. Simon*, associate consultant, Battelle Memorial Institute, Columbus, Ohio

Vice-Chairman: *M. R. Lohman*, dean, Oklahoma Institute of Technology, Oklahoma A&M College, Stillwater, Okla.

Strength Characteristics of Rock Samples Under Hydrostatic Pressure, by *R. O. Bredthauer*, Hughes Tool Co., Houston, Texas[1]

On Porosity and Rock Strength, by *A. D. Topping*, Goodyear Aircraft Corp., Akron, Ohio[1]

9:00 a.m. — **Gold Room**

Transportation (I)

Session 3—Improved Maintenance Practices

Chairman: *H. T. Chilton*, Maintenance Superintendent, Service Pipe Line Co., Tulsa, Okla.

Vice-Chairman: *D. E. White*, Assistant Chief Engineer, Magnolia Pipe Line Co., Dallas, Texas

Maintenance Welding High-Test Line Pipe, by *A. M. Hill* and *F. W. Zilm*, Service Pipe Line Co., Tulsa, Okla. (Paper No. 56—PET-15)

Prevention of Destructive Engine Failure by Spectrographic Analysis of Crankcase Oil, by *R. T. Blades*, *R. E. Linnard*, and *C. B. Threlkeld*, Phillips Petroleum Co., Bartlesville, Okla.

2:00 p.m. — **Embassy Room**

Refining (II)

Session 4—Job Evaluation and Industrial Psychology

Chairman: *T. M. Mixon*, superintendent of mechanical-engineering, research, and engineering department, Ethyl Corp., Baton Rouge, La.

Vice-Chairman: *Drew M. Young*, personnel supervisor, The Atlantic Refining Co., Dallas, Texas

Job Evaluation: A System of Salary Determination, by *A. deLeon*, Warren Petroleum Corp., Tulsa, Okla. (Paper No. 56—PET-18)

Psycholological Tests in an Engineering Department, by *J. M. Parish*, Louisiana Division, The Dow Chemical Co., Baton Rouge, La. (Paper No. 56—PET-3)

2:00 p.m. — **Gold Room**

Production (II)

Session 5—Drilling Equipment

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[1] Papers not available—see box on page 772.

Chairman: *J. H. Abernathy*, vice-president, Big Chief Drilling Co., Oklahoma City, Okla.

Vice-Chairman: *L. W. Randerson*, chief of Drilling Section, Magnolia Petroleum Co., Dallas, Texas

Development of a Magnetic-Particle Brake for Oil-Field Drilling Rigs, by *W. B. Baylor*, The Baylor Co., Inc., Houston, Texas

Offshore Mobile Units—Present and Future, by *R. J. Howe* and *B. G. Collipp*, Shell Oil Co., Houston, Texas

2:00 p.m. **Silver Room**

Transportation (II)

Session 6—Recent Developments in Gas Transmission Equipment

Chairman: *J. J. King*, vice-president, Tennessee Gas Transmission Co., Houston, Texas

Vice-Chairman: *T. S. Bacon*, director of research and development, Lone Star Gas Co., Dallas, Texas

Gas-Engine-Driven Centrifugal Compressors, by *G. B. McIntosh, Jr.*, Transcontinental Gas Pipe Line Corp., Houston, Texas; *H. L. Cline*, Transcontinental Gas Pipe Line Corp., Houston, Texas, *Rocco Lochiano*, Gulf Interstate Gas Co., Houston, Texas; and *R. P. Younghaus*, Gulf Interstate Gas Co., Houston, Texas

Apparatus for Sampling Particulate Matter in High-Pressure Gas Streams, by *R. L. Solnick*, The Fluor Corp., Ltd., Los Angeles, Calif. (Paper No. 56—PET-16)

2:00 p.m. **Mustang Room**

Materials (I)

Session 7—Protective Linings for Pressure Vessels and Piping

Chairman: *C. M. Vogrin*, section engineer, The M. W. Kellogg Co., New York, N. Y.

Vice-Chairman: *J. C. Spaulding*, petroleum engineer, Sun Oil Co., Dallas, Texas

Fabrication Aspects of Aluminized Pipe and Piping Components, by *E. M. Peloubet*, Aluminum Processing Plant, Arthur Tickle Engineering Works, Brooklyn, N. Y.

Radiographic Inspection of Lead Linings During Fabrication, by *William Skiba*, Bayway Refinery, Esso Standard Oil Co., Linden, N. J. (Paper No. 56—PET-11)

TUESDAY, SEPTEMBER 25

9:00 a.m. **Embassy East Room**

Refining (III)

Session 8—Air Cooling

Chairman: *Leroy Culbertson*, assistant manager, natural gasoline department, Phillips Petroleum Co., Bartlesville, Okla.

Vice-Chairman: *C. M. Simmang*, professor, mechanical-engineering department, Agricultural & Mechanical College of Texas, College Station, Texas

Problems Encountered in the Selection and Use of Air-Cooled Heat-Transfer Equipment, by *T. H. King*, and *D. D. Brown, Jr.* Magnolia Petroleum Co., Dallas, Texas (Paper No. 56—PET-12)

Problems Encountered in the Manufacture and Rating of Air-Heat Exchangers and Their Suggested Solution, by *J. I. Carter*, Arrow Industrial Manufacturing Co., Tulsa, Okla. (Paper No. 56—PET-6)

9:00 a.m. **Embassy West Room**

Production (III)—Transportation (III)

Session 9—Symposium on Automation—From Well-Head to Pipe Line

Chairman: *B. K. Ledgerwood*, senior associate editor, *Control Engineering*, McGraw-Hill Publication, New York, N. Y.

Vice-Chairman: *R. L. Geer*, development engineer, Shell Oil Co., Midland, Texas

Speakers

Howard J. Endean, head, Fluid Lifting and Handling Section, Production Engineering Division, Gulf Research & Development Co., Pittsburgh, Pa.

S. H. Pope, division mechanical engineer, Gulf Oil Corp., Tulsa, Okla

Mathew L. Freeman, Controls Division Engineer McEvoy Co., Houston, Texas

9:00 a.m. **Gold Room**

Production (IV)

Orders for Technical Papers

Only copies of *numbered* ASME papers will be available. Some of these papers may not be available in time to permit your receiving them in advance of the conference. Your order will be mailed only when the complete order can be filled unless you request that all papers available ten days before the conference be mailed at that time. Please order only by paper *number;* otherwise the order will be returned. The final listing of available technical papers will be found in the issue of Mechanical Engineering containing an account of the conference.

Copies of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. Postage Stamps, free coupons, or coupons which may be purchased from the Society. The coupons in lots of ten are $2 for members; $4 for nonmembers.

Copies of the unnumbered papers, listed in the program, *are not available* because the review of these manuscripts had not been completed when the program went to press. The author's name and paper number will appear with the paper title in the program as well as the issue of Mechanical Engineering containing an account of the conference.

Session 10—Symposium—Application of Diesel Electric Railway Equipment to Drilling Rigs

Chairman: *H. L. Willke*, chief engineer, The National Supply Co., Toledo, Ohio

Vice-Chairman: *J. A. Whitesides*, manager, Drilling Equipment Division, Continental Supply Co., Dallas, Texas

Speakers

B. H. Hefner, chief electrical engineer, Electro-Motive Division, General Motors Corp., LaGrange, Ill.

F. A. Compton, Jr., manager of engineering, Locomotive & Car Equipment Division, General Electric Co., Erie, Pa.

H. D. Redding, assistant Division Rig Superintendent, Phillips Petroleum Co., Houston, Texas

9:00 a.m. **Mustang Room**

Materials (II)

Session 11—Design and Fabrication of Piping and Fittings

Chairman: *A. G. Barkow*, superintendent of inspection, Natural Gas Pipeline Co. of America, Chicago, Ill.

Vice-Chairman: G. E. Nevill, manager of quality control, Cameron Iron Works, Inc. Houston, Texas.

Design of Manifold Fittings for Special Temperature and Pressure Conditions, by *W. R. Wollering*, Ladish Co., Cudahy, Wis.

Recent Aspects of Fabrication of High-Strength, High-Temperature Pipe in the Petroleum Industry, by *E. A. Sticha*, Crane Co., Chicago, Ill.

Performance of 6061-T6 Aluminum Flanged Pipe Assemblies Under Hydrostatic Pressure, by *H. H. George*, Tube Turns, Louisville, Ky.; *E. C. Rodabaugh*, Tube Turns; and *Marshall Holt*, Alcoa Research Laboratories, New Kensington, Pa.

2:00 p.m. **Embassy East Room**

Refining (IV)

Session 12—Panel Discussion of Section 3, ASA B31 Code for Pressure Piping—Petroleum Refinery Systems

Chairman: *F. S. G. Williams*, chairman, ASA B31 Sectional Committee on Code for Pressure Piping; Taylor Forge & Pipe Works, Chicago, Ill.

Vice-Chairman: *N. P. Chestnutt*, chief engineer, Southern Union Gas Co., Dallas, Texas

Panel Members

W. P. Kliment, member, Subcommittee 3 on Petroleum Refinery Piping Systems of ASA-B31 Sectional Committee on Code for Pressure Piping; Crane Co., Chicago, Ill.

K. W. Haupt, chairman, Subcommittee 6 on Fabrication Details of ASA-B31 Sectional Committee on Code for Pressure Piping; Pipe Fabrication Institute, Cincinnati, Ohio

J. C. Siegle, member, Subcommittee 3 on Petroleum Refinery Piping Systems of ASA-B31 Sectional Committee on Code for Pressure Piping; The Youngstown Sheet & Tube Co., Youngstown, Ohio

H. H. Hall, member, Subcommittee 3 on Petroleum Refinery Piping Systems of ASA-B31 Sectional Committee on Code for Pressure Piping; Hudson Engineering Corp., Houston, Texas

E. B. Stolle, member, Subcommittee 3 on Petroleum Refinery Piping Systems of ASA-B31 Sectional Committee—Code for Pressure Piping; Midwest Piping Co., Inc., Clifton, N. J.

D. W. Motter, secretary, Subcommittee 3 on Petroleum Refinery Piping Systems of ASA-B31 Sectional Committee on Code for Pressure Piping; Esso Research and Engineering Co., Linden, N. J.

D. J. Bergman, member, Subcommittee 3 on Petroleum Refinery Piping Systems of ASA-B31 Sectional Committee on Code for Pressure Piping; Universal Oil Products Co., Des Plaines, Ill.

J. P. Mooney, chairman, Subcommittee 3 on Petroleum Refinery Piping Systems of ASA-B31 Sectional Committee on Code for Pressure Piping; Humble Oil & Refining Co., Baytown, Texas

2:00 p.m. **Embassy West Room**

Refining (V)

Session 13—Maintenance

Chairman: *E. J. Hander*, head, Special Services Division, Asiatic Petroleum Corp., New York, N. Y.

Vice-Chairman: *H. H. Jones*, chief engineer, Sid Richardson Industries, Fort Worth, Texas

The Maintenance Challenge in a Petrochemicals Plant, by *P. S. Skaff*, Sabine River Works of E. I. du Pont de Nemours & Company, Inc., Polychemicals Department, Orange, Texas (Paper No. 56—PET-2)

Maintenance Organization Factors in the Modern Refinery, by *C. H. Trotter*, Phillips Petroleum Co., Bartlesville, Okla. (Paper No. 56—PET-5)

9:00 a.m. **Embassy East Room**

Refining (VI)

Session 14—Mechanical Design

Chairman: *John R. Sherman*, Division Gas and Gasoline Supervisor, Gulf Oil Corp., Fort Worth, Texas

Vice-Chairman: *Venton L. Doughtie*, professor, mechanical-engineering department, University of Texas, Austin, Texas

Hydraulic Drives Using Rich Oil Power Units, by *B. J. Thompson*, Warren Petroleum Corp., Tulsa, Okla. (Paper No. 56—PET-9)

Selection of Materials for Construction of Catalytic Reforming Units, by *J. K. Deichler*, The Atlantic Refining Co., Philadelphia, Pa.; *J. James Hur*, The Atlantic Refining Company, Philadelphia, Pa.; and *G. Richard Worrell*, The Atlantic Refining Co., Philadelphia, Pa. (Paper No. 56—PET-8)

Mechanical-Design Problems Connected With Ammonia Synthesis, by *C. E. Freese*, The Fluor Corp., Ltd., Los Angeles, Calif. (56—PET-1)

9:00 a.m. **Gold Room**

Production (V)

Session 15—Drilling Equipment—Design and Maintenance

Chairman: *Henry H. Meredith, Jr.*, senior supervising engineer, Humble Oil & Refining Co., Houston, Texas

Vice-Chairman: *Hugh Falk*, drilling engineer, The Atlantic Refining Co., Dallas, Texas

Design Applications for Air-Drilling Equipment,

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[1] Papers not available—see box on this page.

by *V. A. LaFave*, El Paso Natural Gas Co., El Paso, Texas

Drilling-Rig Maintenance Costs, by *R. W. True*, Big Chief Drilling Co., Oklahoma City, Okla., and *T. W. G. Richardson*, Shell Oil Co., Tulsa, Okla.

9 : 00 a.m. **Silver Room**

Transportation (IV)

Session 16—Pipeline Operation and Design I

Chairman: *J. E. Green*, assistant area manager, Shell Pipe Line Corp., Cushing Okla.

Vice-Chairman: *D. A. Roach*, chief engineer, Phillips Pipe Line Co., Bartlesville, Okla.

Experience With Positive Displacement Meters in Oil Pipeline Service, by *D. C. McKinley*, Interstate Oil Pipe Line Co., Shreveport, La.

Remote Control and Operation of Booster Stations on the Platte Pipeline Systems, by *F. D. Marts*, Platte Pipe Line Company, Kansas City, Mo. (Paper No. 56—PET-14)

9 :00 a.m. **Embassy West Room**

Refining (VII)

Session 17—Design and Construction

Chairman: *H. E. Allspach*, assistant plant manager, Carbide & Carbon Chemicals Co., Texas City, Texas

Vice-Chairman: *Dan T. McDonald*, vice-president, The Murmanill Corp., Dallas, Texas

Models as a Design Tool, by *B. L. Paton*, The Fluor Corp., Ltd., Los Angeles, Calif. (Paper No. 56—PET-4)

Program for Controlling Construction Costs, by *J. E. Ross*, The Dow Chemical Co., Texas Division, Freeport, Texas (Paper No. 56—PET-10) .

2 : 00 p.m. **Embassy Room**

Refining (VIII)

Session 18—Panel Discussion of ASME Unfired Pressure Vessel Code

Chairman: *E. O. Bergman*, chairman, Subcommittee on Unfired Pressure Vessels of ASME Boiler and Pressure Vessel Committee; C. F. Braun & Co., Alhambra, Calif.

Vice-Chairman: *C. E. Rawlins*, member, Subcommittee on Unfired Pressure Vessels of ASME Boiler and Pressure Vessel Committee; Phillips Petroleum Co., Bartlesville, Okla.

Panel Members

J. F. Sebald, member, Subcommittee on Unfired Pressure Vessels of ASME Boiler and Pressure Vessel Committee, Worthington Corp., Harrison, N. J.

G. E. Fratcher, member Subcommittee on Unfired Pressure Vessels of ASME Boiler and Pressure Vessel Committee, A. O. Smith Corp., Milwaukee, Wis.

O. R. Carpenter, member, Subcommittee on Unfired Pressure Vessels of ASME Boiler and Pressure Vessel Committee, The Babcock & Wilcox Co., Barberton, Ohio

G. S. Chadwick, Jr., member, Subcommittee on Unfired Pressure Vessels of ASME Boiler and Pressure Vessel Committee, Carbide & Carbon Chemicals Co., South Charleston, W. Va.

T. R. Hardin, member, Subcommittee on Welding of ASME Boiler and Pressure Vessel Committee, Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.

F. S. G. Williams, member, Main Committee of ASME Boiler and Pressure Vessel Committee, Taylor Forge and Pipe Works, Chicago, Ill.

2 : 00 p.m. **Gold Room**

Production (VI)

Session 19—Equipment Design

Chairman: *Alex Quayle*, director of engineering, Oil Well Supply Division, United States Steel Corp., Dallas, Texas

Vice-Chairman: *J. R. McEntee*, chief mechanical engineer, Shell Oil Co., Houston, Texas

Pulsation Absorbers—Their Design and Application, by *H. M. Wyatt, Jr.*, Oklahoma Institute of Technology, Oklahoma A&M College, Stillwater, Okla.

A Comparison of Various Hydraulic Drives on Oil-Field Equipment, by *W. A. Eskbridge*, Clark Equipment Co., Tulsa, Okla.

2 : 00 p.m. **Silver Room**

Transportation (V)

Session 20—Pipeline Operation and Design II

Chairman: *William T. Pyott*, executive vice-president, Pipe Line Technologists, Inc., Houston, Texas

Vice-Chairman: *W. H. Carson*, dean, School of Engineering, University of Oklahoma, Norman, Okla.

Cold Weather Pipelining, by *J. E. Lyle*, Imperial Pipeline Co., Ltd., Edmonton, Alberta, Canada (Paper No. 56—PET-17)

Design and Selection of Motor-Operated Valves, by *A. Brothman*, Techniflex Corp., Port Jervis, N. Y.

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[1] Papers not available—see box on page 772.

New York City Recommended by Task Committee on Engineering Center Site

Report now in hands of the governing boards of Founder Societies and AIChE

The Presidents of the American Society of Civil Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; The American Society of Mechanical Engineers; American Institute of Electrical Engineers; and the American Institute of Chemical Engineers announced at noon on June 27 in New York, N. Y., that they have received the report of the Special Task Committee of Fifteen appointed to make recommendations with regard to the site of the Engineering Societies Center. Action on these recommendations is to be taken by the several governing boards. (See page 792 of this issue for the ASME Council action.)

The recommendations are as follows:

"Item 1—The Engineering Societies Center be located in New York City

"Item 2—The 39th–40th Street site be continued in use as the site of the Engineering Societies Center. If rebuilding in that area proves impracticable, a comparable site should then be sought in midtown New York.

We suggest that the Governing Boards also adopt these further recommendations for inaugurating action:

"Item 3—The United Engineering Trustees, Inc., be authorized to take proper legal action for expansion by the addition of the American Institute of Chemical Engineers to the incorporators when properly qualified.

"Item 4—The United Engineering Trustees, Inc., be authorized to raise money and accept contributions; accept the offer of the Kelly Committee; place contributions in UET Capital Fund Assets; employ architects, engineers, and attorneys; let contracts for reconstruction of the present Engineering Societies building and/or a new building or buildings; pay all costs out of the Capital Fund Assets; and operate and maintain the new Engineering Societies Center.

"Item 5—The plans for the new and enlarged Engineering Societies Center be made with ample optimism with respect to the future growth of the five societies immediately involved. These facilities should be such as to attract and hold all of the Engineering Profession, thus fostering unity and co-operation along broad lines.

"The vote of the Special Task Committee, the members of each of the five Societies voting as a unit as prescribed, is unanimously in favor of these recommendations.

"We are submitting a detailed report, prepared in collaboration with our consultants, McKinsey & Company. We are prepared to discuss our findings, conclusions, and recommendations with you at your request. Upon your acceptance of this report, we will consider our assignment completed and request that this Special Task Committee then be discharged.

(Signed) ASCE: Mason G. Lockwood, Frank A. Marston, Ralph B. Wiley

(Signed) ASME: E. G. Bailey, James W. Parker, James M. Todd

(Signed) AIME: Harold Decker, H. DeWitt Smith, Secretary, Clyde E. Williams

(Signed) AIEE: Ernst S. Fields, J. Elmer Housley, L. M. Robertson

(Signed) AIChE: Barnett F. Dodge, Chairman, R. Paul Kite, Thomas H. Chilton."

ASME 1957 Nominating Committee Organizes

Elected at the 1956 Semi-Annual Business Meeting of The American Society of Mechanical Engineers, Cleveland, Ohio, June 18, 1956, the 1957 National Nominating Committee at its organization meeting chose Ernest H. Hanhart as chairman and Raymond H. Stockard as secretary.

The 1956 National Nominating Committee is composed of the following:

Region I. Representative, Stefan L. Grapnel, research engineer, Belding-Corticelli Company, Putnam, Conn.; *1st Alternate*, Roger M. Scott, sales engineer, Wire Division, Morgan Construction Company, 15 Belmont St., Worcester, Mass.; *2nd Alternate*, John P. Heumann, mechanical-engineering research department, Olin Mathieson Chemical Corporation, 275 Winchester Avenue, New Haven 4, Conn.

Region II. Representative, Henry F. J. Skarbek, plant manager, American Aluminum Casting Company, 326 Coit Street, Irvington, N. J.; *1st Alternate*, James L. O'Neill, manager, Industrial Sales Division, Daystrom Electric Corporation, 753 Main Street, Poughkeepsie, N. Y.; *2nd Alternate*, U. A. Rothermel, mechanical engineer, Republic Flow Meter Company, 26-09 Jackson Avenue, Long Island City 1, N. Y.

Region III. Representative, Ernest H. Hanhart, consulting engineer, 626 Bartlett Avenue, Baltimore 18, Md.; *1st Alternate,* George R. Leavitt, project engineer, Taylor Instrument Companies, 95 Ames Street, Rochester 1, N. Y.; *2nd Alternate,* William E. Hammond, chief engineer, The Air Preheater Corporation, Andover Road, Wellsville, N. Y.

Region IV. Representative, Thomas J. Judge, co-ordinator of power plants, Southern Kraft Division, International Paper Company, Box 1649, Mobile, Ala.; *1st Alternate,* Kenneth R. Daniel, vice-president and chief engineer, American Cast Iron Pipe Company, P.O. Box 2603, Birmingham, Ala.; *2nd Alternate,* Harold K. Couch, sales engineer, Brown & Morrison, 207 Liberty Life Building, Charlotte 2, N. C.

Region V. Representative, John F. Cunningham, Jr., associate engineer and sales, Midwest Equipment Company, 545 W. Broad Street, Columbus 8, Ohio; *1st Alternate,* Arthur B. Heiberg, development engineer, Firestone Tire and Rubber Company, 1200 Firestone Parkway, Akron 17, Ohio; *2nd Alternate,* Winthrop I. Collins, district sales manager, The Babcock & Wilcox Company, 2730 Koppers Building, Pittsburgh, Pa.

Region VI. Representative, George H. Frost, general engineering department, Iowa State College, Ames, Iowa; *1st Alternate,* Charles A. Davis, engineer, Deere & Company, 1325 Third Avenue, Moline, Ill.; *2nd Alternate,* Robert D. Teece, manager, Central Engineering Division, Hernischfeger Corporation, 4400 W. National Avenue, Milwaukee 15, Wis.

Region VII. Representative, Donald S. Angell, design engineer, Kaiser Aluminum and Chemical Corporation, Trentwood, Spokane, Wash.; *1st Alternate,* Walter A. Biddle, manager, Fresco Distributing Company, 21 E. Durango, Phoenix, Ariz.; *2nd Alternate,* Leonard C. Koke, senior mechanical engineer, Atomic Products Division, General Electric Company, Richland, Wash.

Region VIII. Representative, Robert W. Cox, mechanical engineer, engineering department, Dallas Power and Light Company, 1506 Commerce Street, Dallas 1, Texas; *1st Alternate,* Robert B. Kinzbach, vice-president, Kinzbach Tool Company, Inc., 2411 Summer Street, Houston 1, Texas; *2nd Alternate,* Allen H. Jensen, engineer, New Orleans Public Service, Inc., Market St., New Orleans, La.

Technical Division. Representative, Otto de Lorenzi, director of education, Combustion Engineering, Inc., 200 Madison Avenue, New York 16, N. Y.; *1st Alternate,* Harry L. Solberg, head, School of Mechanical Engineering, Purdue University, Lafayette, Ind.; *2nd Alternate,* Jess H. Davis, president, Stevens Institute of Technology, Hoxie House, Hoboken, N. J.

Codes and Standards. Representative, Hendley N. Blackmon, engineering manager, Association Activities, Westinghouse Electric Corporation, Office 7-L-38, East Pittsburgh, Pa.; *1st Alternate,* A. William Meyer, assistant director of design, Brown & Sharpe Manufacturing Co., Providence 1, R. I.; *2nd Alternate,* Rawleigh MacJohnson, engineer, Charge of Tests, Compressor Division, Ingersoll-Rand Company, Phillipsburg, N.J.

Administrative. Representative, Raymond H. Stockard, director of placement, University of Rhode Island, Kingston, R. I.; *1st Alternate,* Robert Nelsen, supervisor, field engineering, General Electric Company, Cincinnati 15, Ohio; *2nd Alternate,* Harold E. Martin, president, Metal and Thermit Corporation, 100 Park Avenue, New York 17, N. Y.

Cleveland Section Plays Host to 1956 ASME Semi-Annual Meeting

Diversified technical fare, special events, inspection trips, make comprehensive program

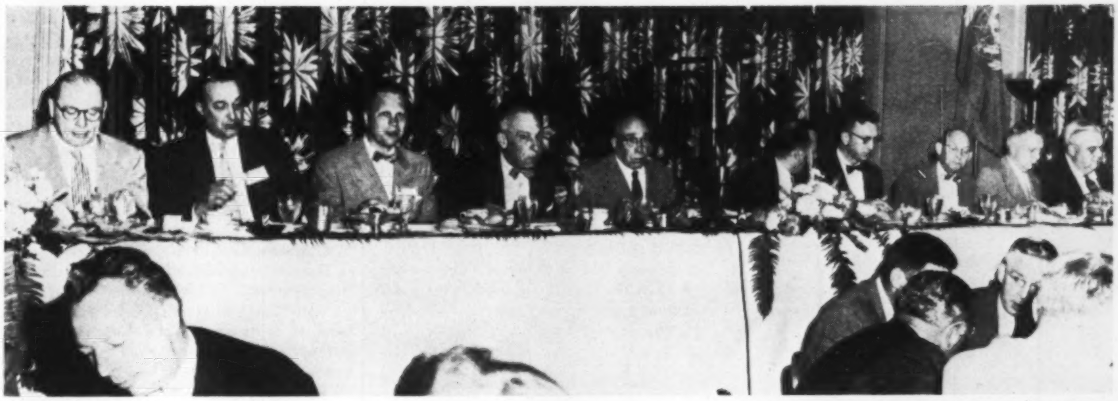
Take more than 80 technical papers presented at some 35 sessions, stir in just the right amount of social activities, sprinkle with assorted plant trips, add a flavorful program for the women, and you come up with a meeting that will whet the appetite of any technical gourmet. These were the basic ingredients served up by the Cleveland Section, host to the Semi-Annual Meeting of The American Society of Mechanical Engineers held at the Hotel Statler, Cleveland, Ohio, June 17–21, 1956, for the 1500 ASME members, guests, and their wives who attended.

In addition the American Rocket Society, an affiliate of ASME, presented 13 papers at four technical sessions during the meeting.

Social events on the ASME program included an "Early Bird" party on Sunday afternoon at which the Cleveland Section played host to members, guests, and their wives who arrived early; the Musicarnival on Sunday evening, where they saw "The King and I," and had coffee with the cast after the performance; and ASME Baseball Night, on Tuesday evening at which ASME members and guests enjoyed a roast beef buffet dinner served in the outfield of Cleveland's giant stadium, met with the ball players, and saw the Cleveland Indians beat the Boston Red Sox by a score of 9 to 7. This, incidentally, snapped the Tribe's string of six losses.

At the more formal feature events, the conferrees heard: Joseph W. Barker, President ASME, deliver the President's Luncheon address on Monday on the subject, "1956: The Biggest Year Yet"; an address by Eger V. Murphree, special assistant to the Secretary of Defense for Guided Missiles, during the American Rocket Society Dinner on Tuesday evening; the 1956 Calvin W. Rice Lecture presented this year by D. F. Galloway, Mem. ASME, Director of Research, Production Engineering Research Association of Great Britain, on the subject, "Production Engineering Research

Acting Mayor Ralph S. Locher of Cleveland, *right,* presents to President Barker the City of Cleveland's proclamation designating the period of June 17–21, 1956, as ASME Week



Partial view of head table during President's Luncheon, keynote event of 1956 ASME Semi-Annual Meeting held in Cleveland, Ohio. Shown, *left to right,* are A. C. Pasini, W. B. Wilkins, K. L. Selby, ASME President J. W. Barker, ASME Past-President D. W. R. Morgan, W. A. Patterson, Ralph S. Locher, Acting Mayor of Cleveland, J. B. Jones, F. W. Miller, and W. H. Byrne

and Its Practical Application in Great Britain"; and a talk on "The Automobile Industry—Then and Now," by Arch T. Colwell, vice-president of Thompson Products, Inc., at the banquet on Wednesday evening.

In addition, inspection trips to facilities in and near Cleveland included National Malleable & Steel Castings Company, Republic Steel Corporation, U. S. Air Force Heavy Press Plant, operated by Aluminum Company of America, Ford Motor Company's Cleveland Engine Plants, Warner & Swasey Company, Standard Oil Company (Ohio) No. 1 Refinery, NACA Lewis Laboratory, and the Eastlake power plant of the Cleveland Electric Illuminating Company.

Feature Events

President's Luncheon

ASME President Barker, principal speaker at the President's Luncheon on Monday, keynote event of the meeting, called on his fellow engineers to take measures to solve educational deficiencies which he said lie at the base of America's shortage of skilled technicians.

He cited figures showing that the Russians had increased the numbers of trained engineers in their country from 41,000 in 1920 to 541,000 in 1954, whereas the United States increase was from 215,000 to 500,000 in the same period.

"To look at it another way," he said, "we started in 1920 with more than five times as many engineers as the Russians; by 1954, they had overcome the gap and passed us by as many engineers as they had to begin with in 1920."

He said that the ratio of engineer-scientists to industrial production employees in the American economy rose between 1900 and 1950 from one in 250 to one in 60.

Dr. Barker traced a large part of the responsibility for the engineering shortage to the schools. He said:

"The number of qualified teachers of science and mathematics in American high schools went down 53 per cent in the past five years, while high-school enrollment was going up 16 per cent. More than half our high schools do not offer courses in physics. Only about half of them offer courses in chemistry."

He urged his audience to "put at the disposal of your communities the one thing that you alone can give: The priceless advantage of your special training and experience in the engineering profession."

"Engineers," he said, "can contribute by serving on official and semiofficial community organizations; by volunteer work in the educational system of the community; and by taking an active interest in the way their children are being taught."

Dr. Barker also devoted portions of his talk to the growth of ASME. The address appears on pages 694-695 of this issue.

Prior to President Barker's address, ASME members and guests were welcomed to Cleveland by Acting Mayor Ralph S. Locher on behalf of Mayor Anthony J. Celebrezze. He brought the Mayor's warm personal felicitations for a successful meeting.

In addition, William A. Shoudy, Fellow ASME, was asked to explain the Old Guard Program. Mr. Shoudy pointed out that it was the aim of the Old Guard Committee to help the young engineer bridge the gap between college and professional life. The Old Guard Committee, he said, was organized 19 years ago to administer the voluntary contributions of Dues Exempt Members. These funds provide travel expense to prize winners and other selected young engineers for attendance at National Meetings and assist the National Junior Committee in various ways.

Mr. Shoudy announced that this year a new prize of $150 was being offered by the Old Guard for the best paper presented by a Student Member. Each contestant at this Semi-Annual Meeting had won the first award at one of the 12 Regional Student Conferences. The final winner, Mr. Shoudy said, would be sent to the 1956 Annual Meeting in New York at the expense of the Old Guard to receive his prize and certificate.

David W. R. Morgan, past-president and Fellow ASME; professor, Drexel Institute of Technology, acted as toastmaster.

American Rocket Society Dinner

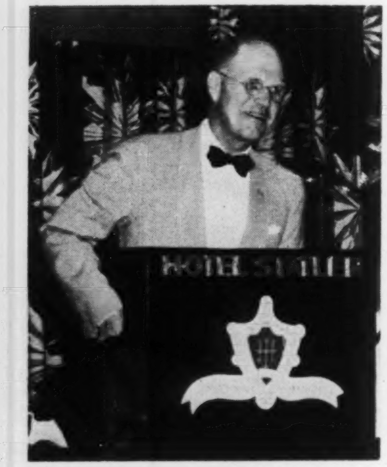
In his first major public address, newly appointed Assistant to the Secretary of Defense for Guided Missiles, Eger V. Murphree told an American Rocket Society Banquet audience on Monday evening that guided missiles are

ASME Officers Nominated for 1957

Members of the ASME Nominating Committee for 1956, Henry B. Atherton, *chairman;* T. N. Graser, *secretary;* Allen T. Kniffen, J. William Putt, Ray N. Benjamin, Henry N. Muller, Jr., Robert W. Mills, Harold A. Johnson, Samuel G. Eskin, Frank S. G. Williams, and Leslie E. Herbert, have nominated for 1957 the following:

Office	Nominee
President	William F. Ryan
Vice-President (for two years)	William H. Byrne, Region II, renominated
	James H. Sams, Region IV
	Rolland S. Stover, Region VI
	Clifford H. Shumaker, Region VIII, renominated
Directors	
Technical	Eugene W. Jacobson (four years)
Administrative	V. Weaver Smith (four years)

Biographical sketches of the candidates for office appear elsewhere in this issue of Mechanical Engineering.



Eger V. Murphree, Special Assistant to Secretary of Defense for Guided Missiles, is shown addressing American Rocket Society banquet

adding new concepts to weapons in terms of range and accuracy. By incorporating guidance into rockets or other missiles, he said, it is possible to obtain a much higher accuracy for a given range or mission than is possible with straight ballistic missiles.

Guided missile developments discussed by Mr. Murphree included the Nike, a surface-to-air missile, developed by the Army. It is currently deployed in the Continental Air Defense and is installed around many of the principal cities. It has a command guidance system and a range and altitude coverage considerably in excess of conventional antiaircraft artillery.

The Terrier is a Navy development and is a surface-to-air missile, particularly adapted for use on ships. The Terrier missile employs the beam-rider-type guidance system and, like the Nike, the Terrier has demonstrated a high-kill capability against aircraft at ranges and altitudes considerably beyond the capabilities of ordinary antiaircraft weapons.

The Talos is also a surface-to-air missile being developed by the Navy for use on shipboard, and there is also interest in its landbase application.

Another surface-to-air missile is the Bomarc, which is being developed by the Air Force. This is a longer range surface-to-air missile than those previously discussed and might properly be described as a pilotless interceptor, Mr. Murphree said.

There are three air-to-air missiles now in operational use, he revealed. From the standpoint of application, the first of these is Sparrow I, developed by the Navy. Another air-to-air missile is the Falcon, which is being developed by the Air Force and is on the threshold of operational use. These missiles are quite effective and improvements are being made. In the air-to-surface field there are two missiles that have been mentioned; one is the Petrel, developed by the Navy, which is now operational, and the second the Rascal, which is under development by the Air Force. Both missiles will permit a bomber to deliver highly effective payloads without the necessity of the bomber's penetrating defenses surrounding the target.

There are a number of missiles for surface-to-surface use mentioned by Mr. Murphree. The Corporal missile was developed by the Army and has a range of over 50 miles and can carry an atomic war head with high accuracy. The Corporal missile is now currently deployed overseas in the European area. This missile is powered by a liquid-rocket engine.

The Regulus is a surface-to-surface missile developed by the Navy and is now operational in cruisers, carriers, and submarines. This missile has demonstrated high accuracy and can carry an atomic war head against shore-type targets with the mother ship standing offshore. The Regulus is an aircraft-type missile and is powered by a turbojet engine. Closely related to the Regulus is the Matador, which is a surface-to-surface missile developed by the Air Force. The Matador is currently in operational use and is deployed overseas. Like the Regulus, it is an aircraft-type missile powered by turbojet engines. The Matador has demonstrated high accuracy and can carry atomic war heads.

The Snark, a long-range surface-to-surface missile, is under development for the Air Force. This is also an aircraft-type missile and is turbojet propelled. The Snark has an intercontinental range and is currently being flight-tested. The Navaho represents a considerable improvement on the Snark. This missile is under development for the Air Force and will have intercontinental-range capability.

Of particular interest for the defense of the United States are the long-range ballistic missiles, according to Mr. Murphree. Two general types are under development; one with intercontinental capability, and the other with an intermediate-range capability. To achieve success as early as possible, duplicate efforts are being carried forward on these two types of missiles. These developments are being pushed hard and rapid progress is being made.

Toastmaster for the affair was Dr. Walter T. Olsen of the Lewis Flight Propulsion Laboratory, NACA, Cleveland, Ohio.

Calvin W. Rice Lecture

Government-supported engineering research in American universities is about 100 times that in Britain, according to Donald F. Galloway, who delivered the 1956 Calvin W. Rice Lecture on Tuesday afternoon. Dr. Galloway is Director of Research, Production Engineering Research Association of Great Britain, Leicestershire, England.

He said that the total expenditure by the British government and industry on engineering research in the universities probably does not exceed $700,000 per annum, compared with over $70 million by the United States Government.

The estimated total expenditure for research and development in the United States last year was about $5 billion, compared with about $700 million in Great Britain, Dr. Galloway revealed. Research work, he said, employs about 500,000 persons in the United States and about 60,000 in Great Britain.

The Production Engineering Research Association (PERA) serves 500 member firms making a variety of products, from domestic utensils and agricultural equipment to gas turbines and precision instruments. Founded in 1946, it has research and other facilities on a 30-acre site near the center of England. Its equipment includes a mobile demonstration unit consisting of a leading vehicle and a trailer. The unit has visited about 300 factories in demonstrations to some 10,000 employees.

Certificate designating Life Membership in ASME is presented by President Barker, *left,* to D. F. Galloway, 1956 ASME Rice Lecturer

Other activities pursued by the association, according to Dr. Galloway, include training and refresher courses ranging from one day to six months in length, and regular and special visits by senior members of the association's staffs to member firms to assist in the solution of production problems. Among some of the results achieved have been the following:

An improved setup for a machining operation that increased tool life 15 times and reduced scrap by 85 per cent;

An assembly of special lamps and other fittings that reduced assembly time from 62 minutes to less than 13 minutes per component and increased the rate of production nearly five times;

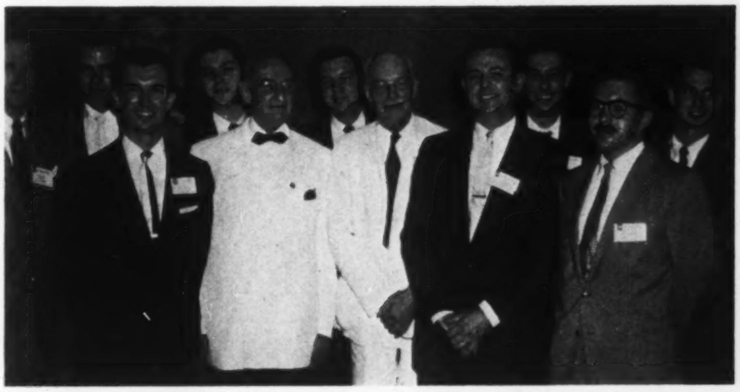
An improved method of machining drawing dies required in large numbers that cut assembly time from 53 minutes to 22 minutes per component and increased tool life by 700 per cent.

The Calvin W. Rice Lecture, founded in 1934, was named to honor the man who served as Secretary of the Society from 1906 to 1934, and to further his ideals to increase understanding between the engineers of the various countries and to broaden the programs of Society meetings. Through this lecture it was hoped to bring leading engineers and scientists to lecture at national meetings outside New York. The lecturer, in this case, Dr. Galloway, is elected a Life Member of ASME.

ASME Banquet

"The Automobile Industry—Then and Now," was deftly covered by Arch T. Colwell, vice-president, Thompson Products, Inc., principal speaker at the Semi-Annual Banquet on Wednesday evening. He reviewed the development of the automobile from the "tin lizzie" of 1900 to the "living-room-on-wheels of today." Mr. Colwell related a host of stories and little-known facts about the early history of the automotive field. He told about such pioneers as Duryea, Winton, Ford, the Dodge brothers, Olds, Packard, Kettering, Sloane, Studebaker, Durant, Buick, Chevrolet, and many others.

Arch T. Colwell, vice-president of Thompson Products, Inc., principal speaker at the banquet, discusses the automobile industry—then and now. Seated is T. Keith Glennan, president of Case Institute of Technology who acted as toastmaster.



Ten of the twelve ASME student members who competed for the 1956 Old Guard Prize are shown with Harold V. Coes, *left,* and William A. Shoudy, *right*

As to the future, Mr. Colwell predicted that the American automobile industry will soon reach the nine-million mark in annual production of passenger vehicles, and may even hit the ten-million mark within a few years.

He also told his audience that:

1 Gas-turbine-powered automobiles will be coming off the production lines as present production equipment requires replacement. They will probably appear one model at a time, since the job of retooling will cost millions of dollars.

2 Fuel-injection systems for piston engines will come even before the gas turbine. These, too, will create a selling point, since they will eliminate the carburetor and the air filter, making it possible to lower the hood and restyle the front end.

3 Changes in suspension systems are "right around the corner." Springs and shock absorbers will give way to hydraulic and pneumatic cushions.

4 America's highway system will expand rapidly to rival anything the world has ever known.

5 Municipal parking and traffic problems will be solved by the complete elimination of on-street parking and the establishment of peripheral parking lots, such as Cleveland's lakefront project. Such systems, he said, will have to be supplemented by rapid and cheap public transportation.

Mr. Colwell emphasized that the gas-turbine and fuel-injection systems are most important from the sales angle, although both will result in greatly improved efficiency and economy of operation.

"Power in passenger cars is not a factor any more," he said. "We already have more than we can use."

He based his prediction of nine and ten-million-car years on the estimated increase in American population and the fact that more families are buying second and even third cars.

As part of the evening's program, President Barker announced that the winner of the Student Member Competition for the 1956 Old Guard Prize was unanimously declared by the Judging Committee to be Joseph W. Jacobson, University of Texas, Austin, Texas, winner from Region VIII (Southern), for his paper, "Metallurgical Yield Stress Observation."

Mr. Jacobson, therefore, will be a guest of the Old Guard at the 1956 Annual Meeting in New York where he will share the platform at the President's Luncheon with President Barker and deliver his paper before the whole Society.

A list of the other papers and their authors which were in this first such competition during this Semi-Annual Meeting follows:

"The Combustion of Uniform Suspension," by Thomas L. Tyler, Dartmouth College, Hanover, N. H., Region I; "The Result of Silicon Purification," by Jerome M. Cook, City College of New York, New York, N. Y. Region II; "The Problem of Water Removal from Modern Aircraft Fuels," by John E. Waldo, University of Maryland, College Park, Md., Region III; "Porous Chromium in Cylinders," by Eliot T. Pyles, Jr., University of Tennessee, Knoxville, Tenn., Region IV; "A Mechanical Engineer Gets a Job," by Franklin L. Erwin, Carnegie Institute of

President Barker, *right,* looks on as Joseph W. Jacobson, winner of the student-paper competition, explains a fine point of his discussion

During ASME Baseball Night roast beef dinner is served to ASME members and guests in the outfield of Cleveland's stadium prior to Cleveland-Boston baseball game

Technology, Pittsburgh, Pa., Region V; "Materials Handling in a Small Sheet-Metal Shop," by Menahem Suliteanu, Illinois Institute of Technology, Chicago, Ill., Region VI, Northern; "Liquification of Helium by the Joule-Thomson Process," by Jamshed A. Modi, Purdue University, West Lafayette, Ind., Region VI, Southern; "The Use of the Piped Elbow as a Flow-Measuring Devise," by Arthur J. Bowker, University of British Columbia, Vancouver, B. C., Canada, Region VII, Pacific NW; "The Design of an Internal-Combustion Engine Producing Direct Hydraulic Power," by Owen C. Barker, University of Utah, Salt Lake City, Utah, Region VII, Pacific SW; "Film Cooling of Gas-Turbine Blades," by Glen R. Horton, Kansas State College, Manhattan, Kansas, Region VIII, Northern; "Insitu Combustion Thermal Oil Recovery Process," by Kenneth W. Maxwell, Jr., Colorado School of Mines, Golden, Colo., Region VIII, Rocky Mountain.

Judges for the competition were Harold V. Coes, Hon. Mem. ASME, Upper Montclair, N. J.; John H. Kincaid, Mem. ASME, Wellman Engineering Company, Cleveland, Ohio; and William A. Shoudy, Fellow ASME, Basking Ridge, N. J.

Dr. Barker also presented 50-year ASME membership pins to the following three Clevelanders: Joseph Breslove, consulting engineer; Roy Harmon Smith, president and general manager, Lamson & Sessions Company; and Fred Hale Vose, professor, Case Institute of Technology.

Other 50-year members, who were announced, but not present, included Claude M. Garland, engineering consultant, Ingleside, Ill; Ibbotson Leonard, consulting engineer, London, Ont., Canada; Joseph A. Polson, professor, University of Florida, Gainesville, Fla.; George E. Rhoads, Altoona, Pa.; Gilbert S. Walker, consulting engineer, Pittsburgh, Pa.; and Merton G. White, field engineer, Marlin Rockwell Corporation, Cincinnati, Ohio.

In addition, President Barker paid tribute to Henry Marx, a member of ASME since it was founded—76 years, who was celebrating his 98th birthday on Friday, June 22, 1956.

Then President Barker introduced Dr. D. F. Galloway, the 1956 Rice Lecturer who conveyed the best wishes of The Institution of Mechanical Engineers for the continued success of ASME. He also cited the value of past and future ASME-IME co-operation. Dr. Galloway paid special tribute to Dr. Barker and C. E. Davies, ASME Secretary, and the ASME Staff for making his trip to the United States and Canada a happy, pleasurable, and useful one.

Mr. Davies was called on to present the results of the 1956 Nominating Committee's nominations for President and other offices of ASME. Mr. Davies announced that William F. Ryan, vice-president, director, and senior consulting engineer of Stone & Webster Engineering Corporation, Boston, Mass., has been nominated to serve as the 1956–1957 President of The American Society of Mechanical Engineers.

Also nominated were the following: As technical director, Eugene W. Jacobson, chief design engineer, Gulf Research & Development Company, Pittsburgh, Pa.; and as administrative director, V. Weaver Smith, vice-president in charge of contracts, the Lummus Company, New York, N. Y.

Nominations for four of the Society's eight regional vice-presidencies also were disclosed:

Region II, William H. Byrne, president and chairman of the board, Byrne Associates, Inc., New York, N. Y.

Region IV, James H. Sams, dean of engineering, Clemson College, Clemson, South Carolina.

Region VI, Rolland S. Stover, owner, R. S. Stover Company, Marshalltown, Iowa.

Region VIII, Clifford H. Shumaker, chairman, Department of Industrial Engineering, Southern Methodist University, Dallas, Texas.

Biographical sketches and photographs of the nominees appear elsewhere in the "ASME News" of this issue.

T. Keith Glennan, president, Case Institute of Technology, Cleveland, Ohio, served as banquet toastmaster.

Technical-Program High Lights

The presentation and discussion of more than 80 technical papers at 35 sessions offered the attendees a wide variety of subject matter. Papers covered topics in the following fields of interest to ASME members: Production engineering, machine design, materials handling, rubber and plastics, education, fuels, air pollution, heat transfer, aviation, safety, power, management, hydraulics, gas-turbine power, instruments and regulators, metal processing, metals engineering, lubrication, and ASME research activities.

Here are a few high lights from some of the papers:

Production Engineering. Applying a protective aluminum-iron alloy layer to the working faces of internal-combustion-engine valves extends their life to from two to three times that of a conventional valve made of the same material. Increased oxidation resistance provided by the alloy layer results primarily from the formation of aluminum and complex iron-aluminum oxides that provide a protective film which inhibits further attack on the base metal. The problems involved in experimentation and research to find an economical way of applying this coating were disclosed at Production Engineering Division session.

At the same session an engineer told how a manufacturer can determine in the design stage the actual cost of different quality specifications in his finished product. He presented a set of charts tabulating the cost differentials for different standards of dimensional tolerances and surface roughness.

The charts traced cost patterns in relation to surface-roughness values, depths of drilled holes, tolerances and surface-roughness values in planing and face-milling operations, dimensional tolerances and surface roughness in cylindrical and internal grinding, in-feed and through-feed values for grinding, and dimensional tolerances for rotary grinding.

Machine Design. Ultrasonic impact grind-

Materials handling in the Soviet Union was discussed by Weldon H. Brandt during a Materials Handling Session

Silas A. Braley, Jr., discusses the properties and applications of silicone rubber at a Rubber and Plastics Session

ing, a method for producing accurately shaped holes in hard substances, is cutting production costs for the metalworking industry. Impact grinding can produce shapes out of solid material to a tolerance of 0.0002 in., and do it in a fraction of the time ordinarily required. The new method, described at a Machine Design Division session, eliminates such operations as "sectioning" of small dies when they are produced in the conventional manner of making the die in sections and fitting the sections together. Now, complex patterns and those in which the sections are too small and fragile to work individually can be made in one piece, and with an appreciable saving in time. Latest improvement to the method, which saw its initial development in 1940, is the employment of a transducer, a device which converts alternating-current cyclic changes into mechanical vibrations of the same frequency.

Another paper revealed that specifications for instruments measuring surface roughness, waviness, and lay of machined surfaces have for the first time been included in a standard. The inclusion of instrument specifications in the new American Standard for Surface Roughness, Waviness, and Lay is an attempt to provide a uniformity of performance among instruments regardless of manufacture.

Rubber & Plastics. Silicone rubbers, able to withstand temperatures from −170 F to +600 F, are making available a long series of practical products heretofore considered impossible, according to a Rubber and Plastics Division paper. A typical application is in tires for jet plane landing gear, an upper-temperature use not suitable for present organic rubbers. Silicone rubber is also unaffected by weathering and ozone action. This makes it suitable for high-altitude service where organic rubbers deteriorate rapidly because of ultraviolet radiation and high ozone concentration. The heat stability of silicone rubber, combined with its excellent dielectric properties, has led to its wide use in the electrical industry. Its ability to remain flexible at very low temperatures makes it useful for seals in high-altitude aircraft, as well as in refrigerating equipment. Silicone rubber can be cycled from normal temperature to below its freezing point many times with no change in the ultimate physical properties. Resistance to chemicals and oils varies with the material. Few materials will stick to silicone rubber, which means that they perform well as material for rollers and conveyer belts for handling sticky materials such as glues and foods.

It is interesting to note that the Rubber and Plastics program was greatly concerned with new polymers. Of the seven papers, three dealt with polymers which had been developed during the past two or three years. The new and exciting possibilites of synthesizing highly regular and specific polymer structures, e.g., crystalline polyethylene and cis-polyisoprene, were especially noteworthy. Furthermore, the versatility of the new polyurethane rubbers was also striking. The engineer today apparently must keep abreast of all these new chemical developments, which offer a continually increasing number of materials of construction. The entire field of synthetic rubbers and plastics is not even two decades old in this country, yet the rate of development has been little short of spectacular. This offers a real challenge to the ingenuity of the design engineer.

Fuels-Air Pollution Controls. A municipal refuse-disposal official declared at Joint Fuels Division-Air Pollution Controls Committee session that there are few consulting engineers who have sufficient incinerator-design experience to turn in a good job in the area of municipal incineration. He urged mechanical engineers to "explore" this field thoroughly, so that they might be in a better position to aid municipalities in the solution of disposal problems. The paper pointed out that the demand for incinerators is expanding rapidly, and that basically design problems in incinerator construction are similar to those in power-plant design, a field that receives concentrated mechanical-engineering attention.

Heat Transfer-Aviation. Problems of the "thermal barrier" in supersonic flight were discussed in a session sponsored jointly by the Heat Transfer and Aviation Divisions. Aircraft and guided missiles are approaching speeds where this heat is a threat to materials and personnel, although the barrier is not as clearly defined as the "sonic barrier," which was widely publicized before construction of craft capable of traveling at supersonic speeds. It was pointed out that the rate of aerodynamic heat transfer into an aircraft may be as high as 10,000 Btu per sq ft per hr at an altitude of 30,000 ft when the speed is twice that of sound in air of that density (i.e., Mach 2.0) and the aircraft is maintained at 120 F. This is equivalent to applying the heat of 260 cu in. of burning natural gas per minute to every square foot of surface of the aircraft. The heat received from the sun would be less than two per cent of this amount, and the heat generated internally—by electronic and radar equipment, mechanical and electrical equipment, and personnel—might amount to 100,000 to 400,000 Btu per hr. It is apparent that any mechanism to dissipate such quantities of heat would penalize aircraft range and performance, the paper said. A partial solution lies in the use of insulating materials to prevent transfer of this heat into the craft. Insulation alone, however, would not be enough, the paper concluded, and suggested that a turboconditioner would be further required. A turboconditioner was defined as "any device or system which may be utilized to cool, pressurize, and/or dehumidify air, equipment, personnel, and/or a physical section of the aircraft structure, either directly or indirectly." In addition, the use of water as an expendable cooling medium was said to be practical, and the utilization of the cooling produced by fuel vaporization is being studied.

A second paper reported the results of a study of refrigerants for use in a conventional vapor-cycle system operating at the high sink temperatures required in supersonic airframes. Conclusions of this study were that the element mercury and alkali metals are most promising materials, although the reactivity of the latter is a serious disadvantage. Mercury was found best because of its inertness. Considerable experience with mercury has been gained in high-pressure steam plants.

Two other papers rounded out the session. One compared refrigerants and gave methods for selecting them to get best performance in various temperature ranges and conditions of use. The other paper gave the results of studies of the conditions to be met by turboconditioning systems. Their results showed the increasing difficulty of cooling as speed increases into the higher Mach numbers.

Power. New steam tables covering a range from 5500 to 10,000 psia and 32 to 1600 F are now available for power-systems calculations. The tables are not based on new data, but are reasonable and consistent extensions of the Keenan and Keyes tables. Developed primarily for industry-wide use during the time required to produce authoritative tables based on experimentation, the new data were prepared by a subcommittee appointed by the ASME Power Division. Sources of the information and the methods used to arrive at the final results were described during a Power Division Session.

In another paper it was pointed out that stacking individual feedwater-heating stages in a common compact tower shell offers economies in construction of power plants

J. T., NACA, Hamrick is shown during a joint Hydraulic-Gas Turbine Power Session

that can save $10 to $15 per installed kilowatt of capacity. The saving is made possible because the incorporation of feedwater heating stages in one unit (1) simplifies the piping system, (2) reduces the number of engineering drawings, (3) minimizes installation time and cost, and (4) reduces building volume—particularly valuable floor space.

Management. The problem of selecting technical managers—experts who combine technical know-how with managerial skill—will become increasingly critical over the next ten years, according to a Management Division paper which outlined a three-step approach to the problem. It involves finding out: (1) key duties to be performed and, if possible, the personal attributes of men who do them well; (2) the management climate surrounding the positions; and (3) the man who can do the job best and who would be happy in the management climate involved.

The paper recommended the use of patterned or structured interviews and psychological tests to determine the ability of the scientist or engineer to stimulate useful thinking among his subordinates; delegate responsibility and authority; develop supervisory capacity in subordinates; exhibit sound economic sense; co-operate as a team member; manage his money, time, and energies; and place the welfare of his customers and associates ahead of his own.

A recent psychological study showing up predominant qualities in top executives earning $20,000 a year or more was cited. These men, the study showed, were all healthy, well-rounded individuals who derived a great deal of their job satisfaction from the growth and development of their companies. They had a good many lasting friendships, high moral and religious standards, high intellectual abilities, and interests that were primarily persuasive, literary, and computational in nature rather than mechanical or scientific.

Safety. More than 40 per cent of all industrial accidents are traceable to a defective plant layout for materials handling, a Safety Division paper warned.

Although some of the materials-handling problems are the responsibility of operating and maintenance personnel, plant-layout engineers should not be touchy about party lines and spheres of responsibility.

The paper recommended three-dimensional layouts as visual aids when planning plant safety since even the most experienced engineer may find it difficult to visualize all conditions that may occur in a plant when relying only on drawings. For example, it is the layout engineer's responsibility to provide the proper amount of space at every work station, adequate space for moving materials, and space for storing it. Provisions should also be made for removal of waste material.

The paper also covered such points as proper plant site, entrances and exits, aisles, elevators, ramps, floors, color, and lighting.

ASME Research Activities. Because of the success of a similar session at the Technology Executives Conference in Ann Arbor, Mich., last January, the ASME Research Planning Committee sponsored a session on ASME Research Activities in order to familiarize the whole membership on this important facet of the Society's activities. H. L. Solberg served as chairman of the session and was ably assisted by John H. Hitchock, vice-chairman.

T. H. Wickenden, chairman of the Research Executive Committee, and G. M. Muschamp, chairman of the Organization Committee, opened the program with a general discussion on the aims and objectives of the Society's Research Committees. Mr. Wickenden noted that occupationally the number of ASME members working in research and development is second only to those working in design and application. Moreover the Constitution and By-laws of the Society specifically state that research shall be one of the primary objectives of ASME. Although the Society has been active for the past 40 years in co-ordinating research programs through its research committees, it has not kept pace with the tremendous growth of research, especially in the last two decades.

Mr. Wickenden further stated that ASME is an excellent medium for promoting, organizing, financing, and directing co-operative research programs at minimum cost. There is a great need for expanded research activities on the part of ASME, because the present stockpile of fundamental information, which was developed many years ago, is low in many areas and must be renewed. ASME can do a more comprehensive job in this field by using a more vigorous approach in the planning and operation of its research programs.

Perhaps one of the ways by which the Society could expand its research activities, said Mr. Wickenden, would be the establishment of a general research fund which would facilitate a more effective operation of current ASME research activities as well as stimulate its future growth. This fund would be sponsored by industry, especially by those firms having employees who are members of the Society.

Mr. Muschamp briefly discussed the establishment and organization of research committees. He said that there is an overlap of research activities in the various Society organizations due in some part to the primary and secondary interests of members. All research committees operate under the jurisdiction of the Research Executive Committee. The REC is mainly a policymaking body reporting to the Board on Technology and consists of five members, each serving a five-year term. In addition, there is a Research Planning Committee which reports to the Research Executive Committee and is responsible for originating new research projects, keeping existing programs active, and recommending the discharge of individual research committees when their activities have ceased. The membership of the Research Planning Committee consists of all members of the Research Executive Committee; a representative from each research committee, usually the chairman; a representative from each professional division; and the research manager.

In many of the professional divisions the subcommittee interested in new developments, and the presentation of such information through papers to the Society, is also known as a "Research Committee." This situation has resulted in considerable confusion among many of the Society's members, said Mr. Muschamp, and it is intended to encourage these professional divisions to change the name of these subcommittees, excluding the word "research" in their titles, but continuing the same function as they have had in the past.

Because of this overlap of membership interest in research and the growing complexity of an expanding ASME research activity, Mr. Muschamp stated that it is planned to issue a "Manual of Operation for ASME Research Committees" which should be of great help to the various research committees in clarifying and standardizing their operations as well as in serving as a handbook for new committee members. In addition, it is planned to issue annually a report of ASME research activities in pamphlet form. This pamphlet will include a report of each research committee including a list of its membership, a financial statement, and a brief digest of the results of its activities during the preceding year. This should go a long way in keeping the Society's membership informed about its research programs. Such a communication link has been needed for many years.

The organization and operation of a typical research committee was discussed next by S. R.

Beitler, chairman of the Research Committee on Fluid Meters. This committee is one of the largest and best integrated of all ASME research committees. Representing government bureaus, education, manufacturers, and users, the main committee has 23 members. In addition 34 persons, not members of the main committee, serve on 17 various subcommittees. Added to these are 11 subcommittee members resulting in a total membership for the whole committee of 88 individuals.

Besides sponsoring its own research programs, the Fluid Meters Committee co-operates with trade associations, such as the American Gas Association and the American Petroleum Institute, in joint research programs concerning problems of mutual interest.

Mr. Beitler emphasized the fact that the committee and its various subcommittees are kept active by maintaining a policy of "weeding out the dead wood." Thus all persons listed as committee members are active participants.

Mr. Beitler said that all research work is conducted by a special subcommittee set up for that purpose. The subcommittee consists of three groups: data, analysis, and special finance. The data group reports the raw information to the analysis and special finance groups. The latter transmits these raw data to the sponsors who may wish to analyze them themselves. The analysis group analyzes the data and writes a report, usually in the form of a paper to the Society, which in turn is supplied through the finance group to the project's sponsors. In addition, progress reports from the data group go continuously through these same channels. In this manner, the results of the research are disseminated to the sponsors at the earliest possible time thus giving them the greatest benefits in return for sponsoring the research program.

Next J. R. Keim gave a report of the ASME Research Committee on Mechanical Pressure Elements. He discussed its history and finances as well as the progress of the subcommittee on Bourdon tubes. One of the new research programs which he mentioned as now getting under way is that of an investigation of the pressure-deflection characteristics of Bourdon tubes.

Further information about the Mechanical Pressure Elements Committee was given by R. M. Conklin, who spoke about the future research plans of the committee, mentioning in particular those on diaphragms. He stated that the research on diaphragms has three objectives:

1 To collect, summarize, and disseminate information on these components.
2 To review critically current work on all diaphragms.
3 To evolve, investigate, and implement research and development in this field.

Following this formal presentation, the meeting was opened to the floor for questions, many of which concerned general aspects of the Society's research activities as well as ASME policy on research. Other questions were directed to the speakers regarding particular points in their talks.

In addition to this session on ASME research activities, there were meetings of various research committees held throughout the four-day Semi-Annual Meeting. One particularly worth noting was that of the Research Committee on High-Temperature Steam Generation at which a 16-mm, sound film in color was shown describing the construction, assembly, and installation of apparatus for investigating the effect of high-temperature atmospheres on metals. This equipment, constructed at the U. S. Naval Engineering Experiment Station, has been installed at the Philip Sporn Power Plant for the three-year research program. This professional quality film is somewhat unique in that the production and photography was all done by the project manager, W. F. Erskine.

American Rocket Society. The 13 papers presented at the four technical sessions sponsored by the American Rocket Society during the ASME Semi-Annual Meeting covered ramjets, liquid propellant rockets, solid propellant rockets, and satellites.

Of particular interest was a paper entitled "The Solar-Powered Space Ship," in which the system characteristics of a hydrogen-propelled lunar space ship were analyzed. According to the paper, the vehicle is carried within a circular orbit by means of chemical-booster stages and continues its flight into the cislunar space under the low propulsive power of a small hydrogen jet which is solar-heated in the focus of a parabolic mirror. The propulsion system, flight mechanisms, and design aspects were discussed.

A complete list of the available ASME papers presented at the meeting may be found on pages 755 to 757 of this issue. In addition, digests of the numbered papers will appear in forthcoming issues of MECHANICAL ENGINEERING.

Inspection Trips and Committees

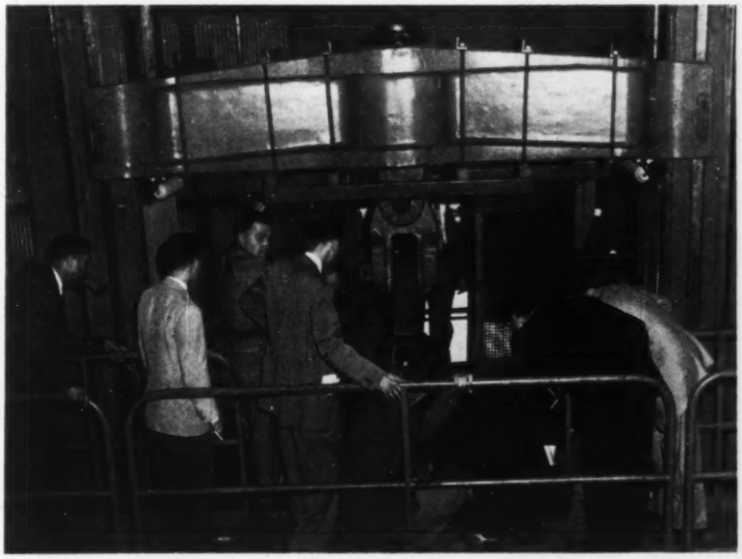
Inspection trips

On Tuesday morning a group visited National Malleable & Steel Castings Company where they saw the casting of freight-car trucks, couplers, draft gears, and yokes for the railroads. In addition they also inspected the Technical Center where research, development, laboratory, and field testing of the company's products are conducted.

In the afternoon a combined trip was scheduled to Republic Steel Corporation and the U. S. Air Force Heavy Press Plant operated by Aluminum Company of America. At Republic Steel the visitors saw the world's widest (98-in.) continuous hot strip mill. They saw 8-in-thick 15-ton slabs heated to 2300 F in heating furnaces from which they passed through a series of rollings which may reduce them to strip steel about $^1/_{12}$ in. thick and a quarter mile long. At the Heavy Press Plant the group inspected the 50,000 and 35,000-ton hydraulic forging presses and supporting equipment such as the large die-sinking machines, straightening and trimming presses, scalping and sawing machines, heat-treat furnaces, ultrasonic and black light inspection facilities.

Also on Tuesday afternoon trips were made to Ford Motor Company's Cleveland Engine Plants, the Warner & Swasey Company, and the Standard Oil Company (Ohio) No. 1 Refinery.

Tours through Ford's engine plants provided the opportunity to see the ideals of automation in action—long clean production lines, along which intricate parts flow smoothly and evenly, just as fast as modern



ASME members visiting National Malleable & Steel Castings Company Cleveland Works Plant and Technical Center examine a specimen after a break test in the 1,000,000-lb test machine at the Technical Center

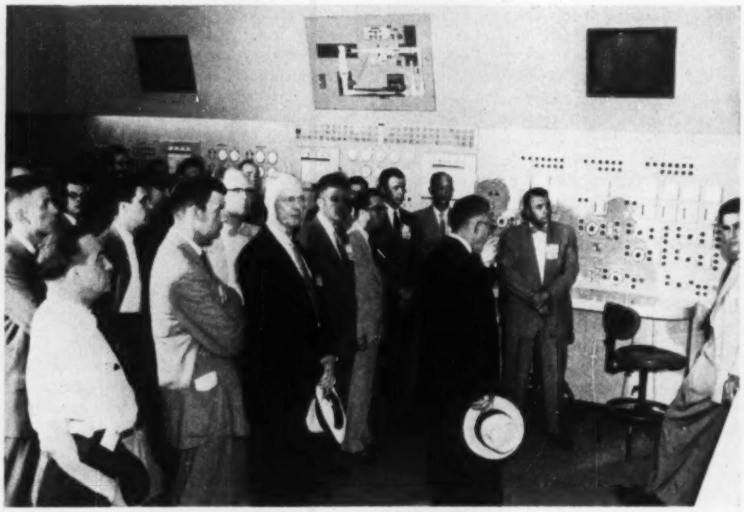
machine tools can handle them. The trips were organized to provide a firsthand view of the complete processing operation—from the cast block to the finished engine assembly running on a test block.

At Standard Oil the visitors saw how crude oil, the basic raw material, is separated into various higher and lower boiling parts which are then subjected to different types of treatment to manufacture the desired products.

The manufacture of turret lathes and automatic lathes by the latest production methods was shown to the group at Warner & Swasey.

The Lewis Flight Propulsion Laboratory of the NACA was visited on Wednesday afternoon. During the tour, ASME members and guests were shown one of the supersonic wind tunnels for propulsion research and its associated equipment. Altitude chambers capable of testing the largest turbojets as well as ramjets over a range of simulated flight Mach numbers and altitudes were inspected. The Rocket Laboratory and typical compressor, turbine, combustion, and engine-materials test facilities were also shown.

On Thursday afternoon a group toured the Eastlake power plant of the Cleveland Electric Illuminating Company. They inspected the three 140,000-kw turbogenerators and the new 240,000-kw unit which was recently placed in service, including the control devices and associated equipment.



Visitors to NACA Lewis Flight Propulsion Laboratory, during ASME Semi-Annual Meeting view control room of the 10 × 10 ft supersonic wind tunnel where research personnel operate and observe performance of aircraft engine and propulsion system models undergoing tests in wind tunnel 250 ft away

Committees in Charge

ASME meetings come under the general supervision of the Meetings Committee.

The technical program is provided by the Society's professional divisions and technical committees. Other features are planned and supervised by committees organized within the host section—in this case the Cleveland Section. In grateful acknowledgement of the many committees whose efforts contributed so substantially to the success of the 1956 Semi-Annual Meeting their personnel is listed as follows: *Meetings Committee:* Jess H. Davis, *chairman;* C. W. Parsons, Glenn R. Fryling, W. B. Wilkins, Arthur M. Gompf, H. Bernard Lindstrom, and J. A. Sweeney, Jr.

Cleveland Section: K. L. Selby, *chairman;* J. E. Gerding, *vice-chairman;* J. R. Lowe, secretary and treasurer.

General Arrangements Committee: Warner Seely, *chairman.*

Technical Events Committee: K. A. Browne, *chairman.*

Finance Committee: J. E. Gerding, *chairman;* Kenneth D. Buck, and Charles E. Richards.

Registration and Information Committee: E. Kostir, *chairman;* Ben Austin, Elliott A. Cayce, Don C. Fabel, Bernie Jaffa, Fred Leonhard, Ralph Lysyk, Harry E. Oberst, and Richard J. Reed.

Publicity Committee: D. R. Harper, *chairman;* Edgar Cummings, Louis Mantey, William Robinson, and Merritt Sampson.

Reception Committee: W. H. Pugh, *chairman;* Kilborn Church, Jack E. Fathauer, Charles E. Richards, Ken J. Sorrace, and Leo F. Spector.

Special Events Committee: R. R. Hayes, *chairman;* and Don Lynch.

Plant Trips Committee: A. R. Griesbach, *chairman;* Arthur K. Beedle, Neal F. Gill, Jesse H. Hall, Jr., Arthur G. Holms, James E. Larson, Robert F. Manley, Howard L. Miller, James E. Morgan, Paul Rolnick, Leo F. Spector, Jack M. Stewart, and George R. Whitmyre.

Hotel, Banquet, and Luncheon Committee: G. E. Shimp, *chairman;* Seymour Datz, Elmer Hisey, Richard Schuerger, and G. T. Williams.

Ladies' Committees: Mrs. K. L. Selby, *chairman,* Women's Auxiliary, Cleveland Section.

Ladies' Events: Mrs. Louis H. Mantey, *chairman;* Mrs. K. A. Browne, Mrs. Lyndon Cole, Mrs. J. E. Fathauer, Mrs. John Gerding, Mrs. William Pugh, Mrs. Kenneth Selby, and Mrs. William Waltermire.

Reception Committee: Mrs. William Pugh, *chairman;* Mrs. T. F. Githens, Mrs. R. D. Junkins, Mrs. E. W. P. Smith, and Mrs. William Tucker.

Registration Committee: Mrs. K. A. Browne, *chairman;* Mrs. A. R. Griesbach, Mrs. J. E. Larson, Mrs. Robert Manley, and Mrs. F. O. Wallene.

Transportation Committee: Mrs. John Gerding, *chairman;* Mrs. Edwin Crankshaw, Mrs. Jesse Hall, and Mrs. E. Edward Winemiller.

Women's Program

Busy Week in Cleveland

In addition to all the social events of the Semi-Annual Meeting, an interesting and enjoyable program kept the women busy during technical-session time. Opening with the "Early Bird" party on Sunday, June 17, the program continued with the Musicarnival when a professional Broadway cast was seen in "The King and I." The following day there was a tour of Industrial Valley by boat down the Cuyahoga River. After luncheon at the famous waterfront Jim's Steak House, buses took the party to the Thompson Products Company Antique Auto and Aviation Museum where they saw a display of old-time automobiles, historic aircraft, famous oil paintings, and a "Gay Nineties" Main Street.

On Tuesday the women went to the NACA cafeteria for luncheon and spent the afternoon on a conducted tour of Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics. There they saw the wind tunnel, research engine laboratory, and other facilities of the laboratory. In the evening they attended the ASME Baseball Night. The Cleveland Indians beat the Boston Red Sox to the tune of nine to seven. A buffet dinner was served and they met the ballplayers before game time.

The next day there were three events, including a visit to the observation room of the Terminal Tower Building where the Univac installation of C&O Railway was observed; tea in the Greenbrier Room, famous "Executive Suite" of the Van Sweringen Brothers, and now the executive offices of the Chesapeake and Ohio Railway Company; and in the evening the Semi-Annual Meeting banquet.

The closing day of the meeting was marked by a luncheon at the University Club and in the afternoon the women were taken on a conducted tour of Cleveland Health Museum, the first museum of its kind in the country.

On display were many fascinating exhibits and on-the-spot tests, such as hearing, sight, and the like. Also shown was the famous "Juno," transparent lady. This is a life-sized glass model whose internal organs light up in sequence as she lectures on anatomy.

In the background is seen adjunct apparatus of the rocket-testing station at NACA Lewis Flight Propulsion Laboratory, which was visited by ASME members during the Semi-Annual Meeting

Semi-Annual Business Meeting

The Semi-Annual Business Meeting of ASME was held on June 18, 1956, in the Hotel Statler, Cleveland, Ohio.

President Barker opened the meeting with the announcement that the 1957 Semi-Annual Meeting will be held June 9–13, 1957, in San Francisco, Calif., and that the Annual Meeting will be held Nov. 25–30, 1957, in New York, N. Y.

The next item on the agenda was the presentation of the names of the nominees for the 1957 National Nominating Committee, who were unanimously elected. The list of personnel of the Committee appears on pages 773 and 774 of this issue.

Under new business, President Barker read the following statement which was prepared for him by the Society's legal counsel:

"A question has been raised by an Internal Revenue agent who is examining our tax returns as to whether the Society is subject to Federal income tax on its income from advertising in its publications, which income may be alleged by the Government to be from a business 'unrelated to the objectives' of the Society. There has been no decision on this matter by the Revenue Service, but we have authorized our attorneys to do everything necessary to obtain a favorable ruling. The raising of this particular tax question may involve scrutiny of other activities of the Society as related to taxes. While we are confident that no such activities of the Sections raise tax questions, there must be over-all supervision of Section activities. With this in mind, I must insist that the Sections of the Society clear with our principal office in New York any activity which might have a bearing upon the problem. This would include solicitation of funds for special purposes, publications, and other activities. No Section is authorized to approach the tax authorities independently."

Mr. Barker further stated that the legal counsel of the Society is preparing a letter for his signature to go out to every Section apprising them particularly of the actions which might conceivably be called into question. This would be desirable in order that Headquarters be kept informed of such actions so that there will be no working at cross purposes on this whole problem.

In other new business, H. H. Snelling suggested that the semi-annual business meetings be less formal and that the President discuss matters in a "fireside chat" manner. This, he felt, would help a great deal in making the members feel that they are closer to the officers and staff of ASME.

H. C. R. Carlson then asked that the President explain the report made by the Special Committee on Honors and Awards during the Council meetings. In his response Dr. Barker reported that the Special Committee's report got the unanimous approval of the Council and that the proposals therein would tend to improve the handling of ASME honors and awards. In essence, he said, the Medals Committee is to be expanded to a committee of 24 in order that there may be a sufficient number of people chosen from the various fields of activity within the Society, such as utility, consultation, publications, machine manufacture, research, and so forth. They would then be assigned to various subcommittees with the responsibility for searching out, checking, and nominating the people for the various awards.

John de S. Coutinho questioned whether a committee should be formed to study the feasibility of establishing within ASME a ceremony similar to the Canadian "Iron Ring Ceremony" or the "calling of an engineer."

In the discussion it was pointed out that this particular ceremony was limited to Canada; also, if any such ceremony were to be established in the United States, it would probably best be handled by EJC as the unity organization.

On motion by W. H. Byrne, it was therefore voted that the President appoint a committee to consider adoption, possibly by ASME, possibly by EJC, of some ceremony analogous to the Canadian ceremony of the "calling of an engineer."

There being no further business, the meeting was adjourned.

ASME Codes and Standards Workshop

Pressure Piping Errata

An Errata Sheet for the Code for Pressure Piping, ASA B31.1—1955, is available from the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for owners of the Code.

1956 ASME Boiler and Pressure Vessel Committee Meeting Held in Montreal, June 19–22

The 1956 out-of-town meeting of the ASME Boiler and Pressure Vessel Committee was held jointly with the twenty-fifth general meeting of the National Board of Boiler and Pressure Vessel Inspectors at the Windsor Hotel, Montreal, Que., Canada, June 19–22, inclusive, as guests of the ASME-EIC International Council. These two bodies met jointly in Canada for the first time, under the cosponsorship of the Engineering Institute of Canada and The American Society of Mechanical Engineers.

Public Safety

Engineers representing all parts of Canada and the United States met to study problems relating to public safety in connection with boilers and pressure vessels.

This type of meeting is one of the few opportunities for assembly and free discussion between the parties interested in the ASME Boiler and Pressure Vessel Code. During a meeting of this nature these interests are represented by the ASME Boiler and Pressure Vessel Committee with the responsibility for preparing the Code rules, the National Board of Boiler and Pressure Vessel Inspectors with responsibility for the promotion of uniform administration of the Code, the Chief Boiler Inspectors of the States and Provinces who enforce the Boiler and Pressure Vessel Laws within their jurisdictions, representatives of the insurance firms who provide Code Inspection Service, manufacturers of Code Boiler and Pressure Vessels, and users of these items of equipment in everyday industrial service.

A panel session was held Wednesday, June 20, which provided opportunity for all present to have the panel members answer specific questions on the rules of the sections of the Code. This type of discussion put all present on the same basis so far as interpretation of the Code rules is concerned and it also served to interchange basic technical information. This session was one of the high lights of the series of meetings.

A regular meeting of the Main Committee was held on Friday, June 22, wherein were considered many questions of practical interest to manufacturers and inspection and enforcement personnel.

The National Board of Boiler and Pressure Vessel Inspectors and the ASME Boiler and Pressure Vessel Committee work with the common purpose of promoting greater safety to life and property in the construction, installation, and inspection of steam boilers and other pressure vessels within the United States and the provinces of Canada through the adoption of uniform rules for such construction; and securing interchangeability between political subdivisions.

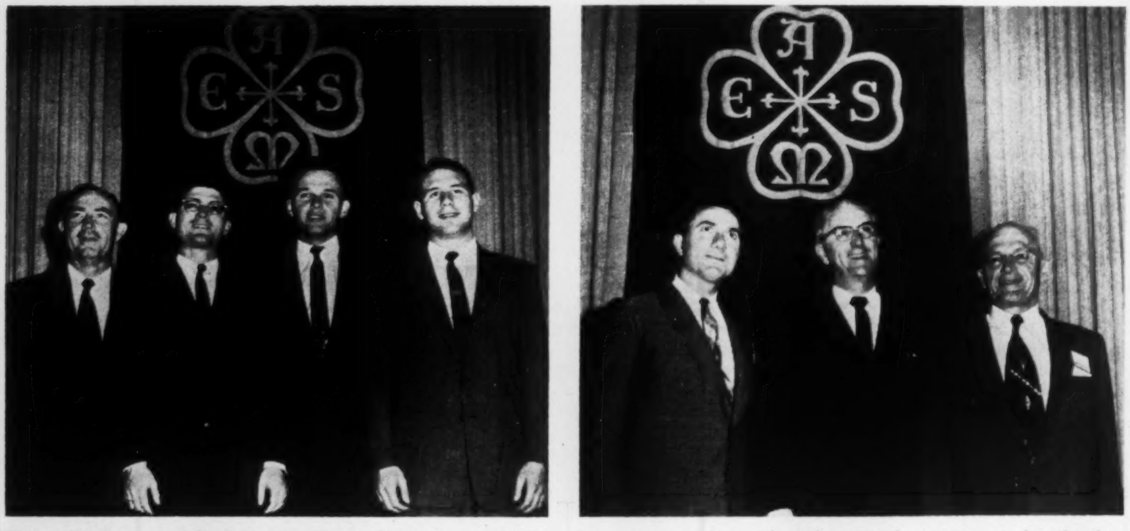
Manufacture of Boilers

The ASME Boiler and Pressure Vessel Committee is made up of engineers in the United States and Canada primarily interested in the manufacture, use, and inspection of boilers and pressure vessels. Aided by the Chief Boiler and Pressure Vessel Inspectors of those cities, states, and provinces who have adopted the construction rules for such equipment as prepared by The American Society of Mechanical Engineers Boiler and Pressure Vessel Committee, the Committee writes rules for the construction of pressure-containing equipment.

Canadian Regulations

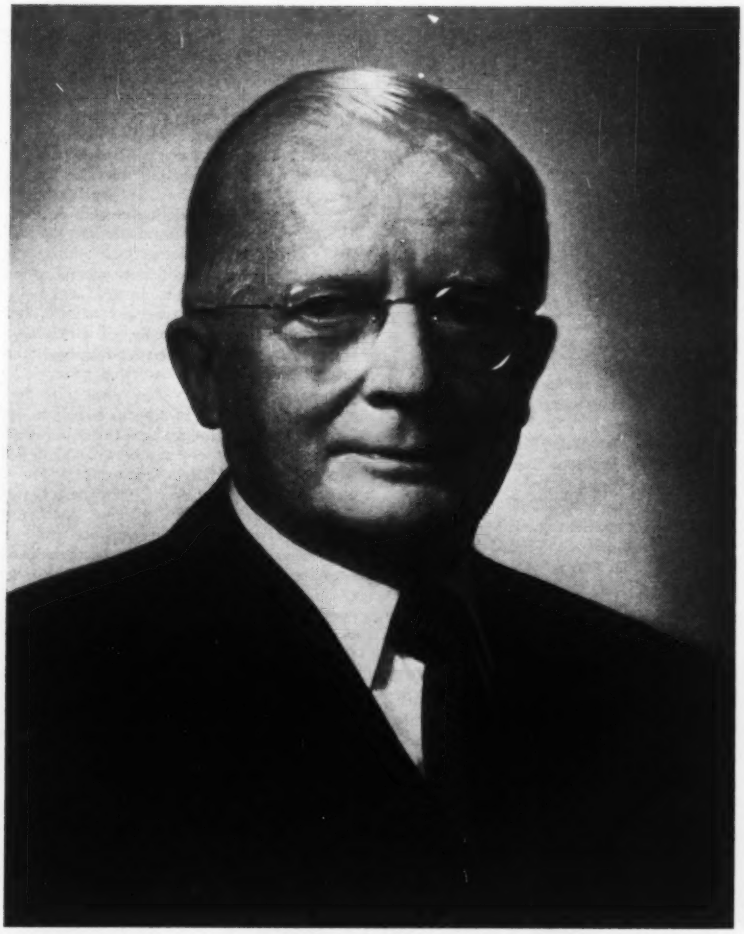
In Canada these rules are regulated under the jurisdiction of the B51 Committee of the Canadian Standards Association of Ottawa. The Chief Boiler Inspectors of each Canadian province are members of this Canadian Standards Association Committee as well as members of the National Board of Boiler and Pressure Vessel Inspectors. Other members of the B51 Committee represented various equipment manufacturers, insurance companies, and the Underwriters' Laboratories of Canada.

The National Board of Boiler and Pressure Vessel Inspectors is an organization of those chief administrative officers of the Boiler and Pressure Vessel laws of the various cities, states, and provinces who have adopted the ASME Code. One of their prime functions is the uniform administration throughout these jurisdictions of the construction rules established by this Code.



Walter W. Preston, *left*, Honors and Awards Chairman, ASME South Texas Section, presents Hugh Scott Cameron Awards at a dinner held by the Section at the Houston Engineers' Club. Recipients, *second from left to right,* are R. R. Steph, Rice Institute; John E. Martin, University of Texas; and Joseph G. Broesche, Texas A&M. The Award is presented each year to outstanding students in recognition of superior personal characteristics and scholarly achievements. In addition to the certificates, recipients are awarded $50 upon completion of graduate work to cover the cost of preparing a thesis, thereby encouraging advanced study. On the same occasion Section Meritorious Awards were presented to members of the Section who have given long and outstanding service to the Society. They are, *left to right,* G. E. Nevill, Cameron Iron Works; C. H. Shumaker, Vice-President, ASME Region VIII, who presented the awards; and F. C. Wagner, superintendent of power stations, Central Power and Light Company. J. J. King, also a recipient of a Section Meritorious Award, was out of town. H. H. Meredith, Jr., 1955 chairman of the Section, was presented a Certificate of Award.

ASME OFFICERS *Nominated for* 1956-1957



William Francis Ryan

Nominated for President

During the 1956 Semi-Annual Meeting of The American Society of Mechanical Engineers in Cleveland, Ohio, June 17–21, 1956, William Francis Ryan, vice-president and senior consulting engineer of Stone & Webster Corporation, Boston, Mass., was nominated by the National Nominating Committee for the office of President of the Society for the year 1956–1957.

Regional Vice-Presidents named by the Committee to serve for a two-year term on the Council of ASME were William H. Byrne, renominated, New York, N. Y., Region II; James H. Sams, Clemson, S. C., Region IV; Rolland S. Stover, Marshalltown, Iowa, Region VI; and Clifford H. Shumaker, renominated, Dallas, Texas, Region VIII.

Directors named by the Committee were the following: *Technical*, E. W. Jacobson, Pittsburgh, Pa., four years; *Administrative*, V. Weaver Smith, New York, N. Y., four years.

Members of the Committee making the nominations were T. N. Graser, representing Region I, *secretary;* A. T. Kniffen, Region II; J. W. Putt, Region III; Ray Benjamin, Region IV; H. N. Muller, Jr., Region V; R. W. Mills, Region VI; H. A. Johnson, Region VII; and H. B. Atherton, Region VIII, *chairman*. Members of the Committee appointed by Council were S. G. Eskin, *Technical;* F. S. G. Williams, *Codes and Standards;* and L. E. Herbert, *Administrative*.

Election of ASME Officers for 1956–1957 will be held by letter ballot of the entire membership, Sept. 27, 1956.

Biographical sketches of the nominees follow on the succeeding pages.

Nominated for President, 1956-1957

William Francis Ryan

William Francis Ryan, the presidential nominee for the year 1956–1957 of The American Society of Mechanical Engineers, is vice-president and senior consulting engineer of Stone & Webster Engineering Corporation. He is a member of the Boston Section, ASME, and resides in West Newton, Mass.

Born in Woodbury, Conn, May 18, 1889, Mr. Ryan attended the public schools in Everett, Mass., and Harvard University, where he received the degree of AB in 1911, and MME in 1913. Since that date he has been continuously employed in engineering work, chiefly in the steam-power field, but with considerable experience in design of chemical and industrial plants and, in recent years, in nuclear projects as well.

Starting with the Interborough Rapid Transit Company in New York, N. Y., during a period of major expansion, he was engaged first on construction, later on operation, of the 74th Street Station, and finally as construction superintendent on a notable installation at the 59th Street Plant. He returned to operation as chief power engineer of the several plants of Wright Martin Aircraft Corporation, in 1917, but later entered the field of power-station design as mechanical engineer for Harry M. Hope Engineering Company in Boston, in 1918.

As power engineer and later as mechanical engineer for subsidiaries of Allied Chemical & Dye Corporation in Syracuse, N. Y., from 1924 to 1929, he designed a high-pressure power plant utilizing the highest steam pressure (900 psi) ever attempted in an industrial plant up to that time. A notable feature of the plant was the adoption of the unit system with no common headers or cross connections between the boilers. That design, now in almost universal use in public-utility plants, was regarded as extremely radical in 1925. While at Syracuse, Mr. Ryan was responsible for the mechanical designs of Allied's great nitrogen fixation plant at Hopewell, Va.

Joining the Stone & Webster organization as mechanical engineer in 1929, Mr. Ryan became assistant chief mechanical engineer, assistant engineering manager, and engineering manager. Throughout that period, Mr. Ryan assumed increasing responsibilities in the whole broad field of the engineering corporation's activities, including reports and appraisals as well as design, and embracing hydroelectric installations, complete electric systems, institutional buildings, and nuclear projects in addition to his earlier activities in steam, heavy chemicals, and general industrial developments. His organization, one of the first in the field of nuclear engineering, is heavily engaged in nuclear work, being employed on design work for three important atomic electric-power generating stations, a nuclear research laboratory, and the country's largest accelerator. He was elected vice-president of the engineering corporation in 1950, and a director in 1954. In that year he relinquished his administrative duties as engineering manager and became senior consulting engineer.

Mr. Ryan has been active in the work of ASME. He became a Junior Member in 1917, a Member in 1924, a Fellow in 1938, and was elected an Honorary Member in 1953. He served for three years on the Executive Committee of the Syracuse Section, being chairman in 1928, and for three years on the Executive Committee of the Boston Section, being chairman in 1934. On the national level he has served on the Executive Committee of the Power Division, chairman in 1932; the Publications Committee, chairman in 1937; the Committee on Professional Conduct, chairman in 1945, the joint AIEE-ASME Committee on Preferred Standards for Large Turbine Generators; and for six years, 1948–1954, represented ASME on the Council of ECPD. In that assignment he was automatically a member of the Board on Education and Professional Status. He was a member for seven years, and for three years chairman of ECPD Committee on Ethics during the long campaign to secure a common code for the entire engineering profession, culminating in the adoption of Canons of Ethics for Engineers by every major professional engineering society in the United States and Canada. He has represented the Society on many other assignments for ECPD and EJC, and is currently the ASME member of the EJC-ECPD Joint Committee on the Practice of Engineering.

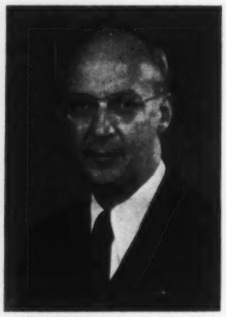
Mr. Ryan has been active in several other professional societies. He is a member of Atomic Industrial Forum. He is also a member of ASEE, serving on the Ethics Committee, the Boston Society of Civil Engineers, the Harvard Engineering Society, of which he was vice-president in 1944 and 1947, also Massachusetts Society of Professional Engineers, of which he was a director in 1946 and vice-president in 1947 and 1948. He has written many papers on technical and professional subjects, a number of which have been printed in Transactions and Mechanical Engineering.

A varsity two-miler in college, he has maintained an active interest in many out-of-door sports. His hobbies are the cultivation of roses, collection of American coins, and the study of medieval Latin manuscripts. He is a member of the American Rose Society, the American Numismatic Society, and the Mediaeval Academy of America.

Mr. Ryan's engineering achievements have been recognized by honorary membership in the Harvard Engineering Society, and the New England Award of Engineering Societies of New England, as well as honorary membership in ASME. In 1954 he was awarded the honorary DS degree by The Catholic University of America.

Nominated for Regional Vice-President To Serve Two-Year Term

W. H. Byrne



James H. Sams

W. H. Byrne

William Henry Byrne, who has been renominated from Region II to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, is president of Byrne Associates, Inc., New York, N. Y. A native of New York, he was born Aug. 11, 1900. He received his engineering training at Stevens Institute of Technology, Hoboken, N. J., and in 1923 was graduated from Polytechnic Institute of Brooklyn with an ME degree. Mr. Byrne, in his capacity as consulting engineer, specializing in engineering services, design, and appraisal work, has been called "an engineer's engineer." He is also director and president of the firm of Stevens and Wood, Inc., which operates in the same field as Byrne Associates, Inc., but tends to specialize in power, marine, and management areas. He stepped directly into electric-utility operations on completing his training as a mechanical engineer when he was employed as assistant engineer at the Hell Gate and Sherman Creek plants of United Electric Light & Power Company—now part of Consolidated Edison Company of New York. He started in the test and efficiency department and ended up as assistant to the chief engineer of the Sherman Creek plant. This affiliation started him in the field of combustion engineering. Subsequently he continued to gain experience in power-plant design, operation, and construction with such firms as Furnace Engineering Company of New York; with Stevens and Wood; as superintendent of production with the Cuban affiliate of American & Foreign Power Company in Havana; and his work with Condenser Service and Engineering Company and the Hagan Corporation. In 1936 he joined the New York Public Service Commission as principal valuation engineer, a post held until 1944. It was in that year that Mr. Byrne organized his own business. In conjunction with his consulting firm, he formed his present principal firm, Byrne Associates, Inc., with the idea of developing the second organization into a versatile, but flexible, group capable of supporting all facets of engineering. In 1946 he acquired Stevens and Wood, Inc., which he fashioned as a vehicle for handling engineering service contracts for government agencies and is now groomed for large-scale contracting in specialty fields, particularly utility and marine design. In 1949, as a result of his varied personal interests, he developed and served as director of the first Bureau of Smoke Control for the New York City Department of Housing and Buildings. He has invented a successful powered-fuel burner and a method for closely controlling temperature in combustion chambers. He has written many technical articles on valuation and power plants. He is associated with several corporations and is a registered professional engineer in 18 states of the United States in addition to holding a National Certification of Qualification. He has been an active member of ASME since 1944 and holds membership in many other professional societies. He is also a member of Tau Beta Pi and Pi Tau Sigma.

James H. Sams

James Hagood Sams, who has been nominated from Region IV to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, received a BS degree in Electrical Engineering from Clemson College in 1924. Cornell University awarded him an EE degree in 1926, and from the University of Michigan he received an MS(ME) and PhD in 1931 and 1937, respectively.

After receiving his degree from Cornell, he worked for a year with the General Electric Company when he left to begin what is considered now an outstanding career in engineering education. For the next seven years he was first an instructor and later associate professor at Clemson College. He was assistant professor at the University of Michigan from 1934 to 1936. In 1936 he returned to Clemson, where today he is dean of engineering, having served previously as associate professor, professor of mechanical engineering, and professor and vice-dean of engineering.

During World War II, he joined the U. S. Air Forces as captain and rose to the rank of colonel.

R. S. Stover

C. H. Shumaker

Dean Sams has taken an active part in ASME affairs since he joined the Society in 1932. He has served as secretary of the Greenville Section and in 1946–1947 was chairman. From 1948 to 1951 he served on Region IV Sections Committee and as chairman, 1950–1951. He was appointed in 1955 for a five-year term to Engineers Registration Committee.

He is holding and has held leading office in several other professional societies, including ASEE; South Carolina Society of Engineers; South Carolina State Board of Engineering Examiners; member of Council, ECPD; and as member of the Scientific Advisory Committee to the South Carolina State Selective Service System.

He has actively participated in his community's affairs as a member and past-president of the Clemson Fellowship Club; member of the board of directors of the Seneca Rotary Club, and this year he was made charter president of the Rotary Club of Clemson.

Rolland S. Stover

Rolland S. Stover, who has been nominated from Region VI to serve as Regional Vice-President of The American Society of Mechanical Engineers, is owner of the R. S. Stover Company of Marshalltown, Iowa. He was born in Blairstown, Mo., Aug. 31, 1909, and after receiving his preliminary education at Lawrence, Kan., earned his BS degree in mining engineering at the University of Kansas in 1933.

The summer between his sophomore and junior years he worked for the Wright-Hargraves Goldmines, Ltd., Kirkland Lake, Ont., Canada, where he gained experience. The following summer he and some fellow students with a college professor tried prospecting for gold in Idaho's Clearwater National Forest Reserve—again all he earned on the venture was experience.

Directly after graduation he left on a prospecting expedition to the Lincoln National Forest in Lincoln County, N. Mex., but soon returned to accept a job with the Gypsy Oil Company at the Seminole, Okla., field.

Since then Mr. Stover has participated in some telling pioneering steps in oil production. At Seminole he was assigned to the first acidizing truck, the first use of acid to increase oil-well production, and when he transferred to the drilling department at Hobbs, N. Mex., he participated in the industry's first use of a portable drilling rig powered by natural-gas engines instead of steam for deep production (4000 ft).

Later when he transferred his interest to the sales side of the industry, he joined the Smith Separator Corporation and while with that firm saw the first well drilled for the Rodessa, La., oil boom.

From 1939 to 1943 he was associated with the Fisher Governor Company of Marshalltown. Then he organized his company which he has operated in Marshalltown since that date. The company serves as manufacturers' representative for several of the nation's leading producers of equipment for power generation, heating, and air conditioning.

One of his hobbies—flying—has paid off. In 1951 he purchased the Nebraska Flying Service at Grand Island, Neb., of which he is now the president. This has become a highly profitable operation. It is a refueling stop under contract to the Flying Tiger Airlines and the Slick Airways, and it handles refueling for about 15 other lines in that area as well as offering flight instructions, aircraft rental, charter, and so on at the municipal airport.

He has been a member of the Society since 1948. In the Central Iowa Section he has held all offices from secretary to and through chairman, having been chairman in 1951–1952. He was also chairman of the National Nominating Committee in 1954–1955.

Mr. Stover has taken active role in the affairs of his community as well as in other professional societies; for example, he is a member and past-president of the Rotary Club of Marshalltown, of the Elks, Moose, Phi Mu Alpha, the Chamber of Commerce (past-president), Heating and Ventilating Engineers, Marshalltown Engineers Club (past-president), City Councilman in Marshalltown, and past-president of the Iowa Engineering Society.

In the American Society of Heating Ventilating Engineers, Iowa chapter, he also has held all offices, having been president in 1950–1951 and chairman of the national chapter Conference Committee in 1955.

He has taken a keen interest in the work of the Iowa Engineering Society since he became a member in 1948. He won the Anson Marston Award in 1951, was treasurer in 1953–1954; president-elect, 1954–1955; and president in 1955–1956, just recently retired from that office.

C. H. Shumaker

Clifford Harold Shumaker, who has been renominated from Region VIII to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, was born in St. Joseph, Mo., Oct. 25, 1907. He was graduated from the University of Kansas in 1930 with a BS degree in industrial engineering. In 1944 he received a professional degree of mechanical engineer from the University. In 1929 he took the Westinghouse Test Course.

His association with Southern Methodist University began in 1930 as an instructor in mechanical engineering. From 1933 to 1936 he was assistant chief draftsman with the consulting engineers' firm of Paulett and Wilson in Salina, Kan. In 1936 he returned to SMU, where he has been assistant professor, associate professor, and professor of mechanical engineering. Since 1952 he has been chairman of the department of industrial engineering. In addition to his regular work on the campus he has also been director of these activities at SMU: from 1940 to 1944, the War Training Program; since 1947, The Institute of Building Material Distrubution; and since 1948, The Institute of Management.

Professor Shumaker became a Junior Member of ASME in 1938 and a Member in 1941. He was a member of the ASME Medals Committee in 1952. He is a member and Institutional Representative, Southwest Section of the American Society for Engineering Education, a member of the American Association of University Professors, and Sigma Tau. He was a recipient of the Sigma Tau Medal and has received an ASME Certificate of Award. He is a registered professional engineer in the State of Texas.

Nominated for Director—Technical and Administrative—To Serve Four-Year Term

E. W. Jacobson

V. W. Smith

E. W. Jacobson

Eugene William Jacobson, who has been nominated to serve as Technical Director of The American Society of Mechanical Engineers for a four-year term, was born in Waterloo, Neb., Jan. 23, 1905. He received two degrees from the University of Nebraska: BS(ME), 1928, and ME, 1938, earning all his college expenses playing saxophone and clarinet and as vocalist with dance orchestras in Lincoln, Neb.

In 1928 he was employed by the Dravo Contracting Company of Pittsburgh, Pa., as a mechanical engineer in the engineering works department. He continued his studies at the Night School of the University of Pittsburgh, during the 1933 Spring Term at Rutgers University in 1933, and later at night at Carnegie Institute of Technology.

He joined his present company, Gulf Research and Development Company, in 1933 as an engineer and progressed steadily until in June, 1955, he was made chief design engineer in charge of the Design Section, Executive Branch. His interest in learning took him back to C.I.T. in 1936 for a special short course in advanced metallurgy and in 1952 to the Massachusetts Institute of Technology for a course in soil and foundation stabilization.

The major work in progress or just started, under Mr. Jacobson's supervision at Gulf Research, include a $500,000 nuclear research laboratory using a 3-million-volt Van de Graaff accelerator, a 44,000-sq-ft production-engineering laboratory, and a heavy-test production research laboratory, complete with equipment.

During World War II, in 1942, he was loaned to the U. S. War Department, Army Ordnance Division, Tank and Automotive Center, Detroit, Mich., to assist in conducting a survey on the design of fuel systems in automotive war vehicles. Later, in 1945, he was again loaned to the War Department as consultant on torsional vibration breakdown of crankshafts in diesel engines in Indian Welding Service.

Mr. Jacobson is a Registered Professional Engineer in the State of Pennsylvania. He holds six patents pertaining to meter testing, amphibian vehicle, apparatus for filling containers of pressure fluids, aerosol-type spraying head, extractor for particulate material, and a device for continuous removal of solids from fluids. Seven other patents have been applied for relating to various other devices and apparatus. He is the author of 18 technical papers which have been published in the leading professional journals and has delivered several addresses and lectures on design developments in the petroleum industry.

In 1942 he was the recipient of the Certificate of Award from the James F. Lincoln Arc Welding Foundation for a paper on "Welding of Automotive Frames." ASME has three times conferred on him a Certificate of Award: For his work as chairman of the Pittsburgh Section, 1947–1948; as secretary and chairman of the Petroleum Division, 1948–1950; and as a member of the Professional Divisions Executive Committee, 1951–1955, and chairman, 1955.

Since Mr. Jacobson joined the Society in 1934 he has participated in the technical as well as professional affairs of the Society, nationally and locally. His activities include the ASME Research Committee on Fluid Meters, Petroleum Division, Professional Divisions Committee, the 75th Anniversary Celebration Lubrication Division, Board on Technology, and the Organization Committee.

In his community he serves as a board member of the Oakmont (Pa.) Water Authority and, since 1953, is also consulting engineer. His hobby is music and his greatest accomplishment has been as tenor soloist in oratorios with the Mendelssohn Choir.

V. W. Smith

V. Weaver Smith, who has been nominated to serve as Administrative Director of the American Society of Mechanical Engineers for a four-year term is vice-president, The Lummus Company, New York, N. Y. He is known for his development of equipment for the oil industry and for his work in the chemical-processing field. In 1917 he developed new processes for the manufacture of chemicals such as benzoic acid and benzaldehyde. Later he developed the processes and designed a plant for the manufacture of benzyl chloride and arsenious chloride. From 1926 to 1931 while with the Superheater Company, New York, he was responsible for the development of new uses for superheated steam, especially for the oil industry. He designed lightweight portable equipment for producing superheated steam which made its use possible in drilling oil wells. He also developed direct-fired tubular heaters for use in the petroleum-processing and refining industry. In 1933 he developed for Lummus lightweight furnace walls for oil heaters, steam boilers, and other oil-heating equipment. In 1936 Mr. Smith developed powerful and mobile high-pressure steam producing boilers to supply the power required for the increasing depths of oil-well drilling. Much of the equipment developed by Mr. Smith has become standard in the oil industry with patents granted in this country and abroad. From 1939 to 1943, acting as project director for Lummus, he had charge of the design and construction of all structures, equipment, controls, and safety devices of plants producing ammonium picrate (Explosive D) built for the Government by Lummus. During the World War II period, Mr. Smith co-ordinated the engineering work of six large steam-generating plants. Mr. Smith is the author of papers on steam drilling. He holds numerous patents. He has served the Society in the Petroleum Division.

Junior Forum

Conducted for the National Junior Committee

by R. A. Cederberg,[1] Assoc. Mem. ASME

The Spirit of St. Louis Junior Award

By George T. Hayes[2]

The Aviation Division of The American Society of Mechanical Engineers has announced that they are accepting papers to be considered for the Spirit of St. Louis Junior Award to be made in 1958. Presentation will be made at the 1958 Annual Meeting of the Society in New York, N. Y. The winner will be selected from the Associate Members of the Society.

The Spirit of St. Louis Junior Award was established in 1938. The award is made for the best paper on an aeronautical engineering subject presented at an ASME meeting during the three-year period preceding the presentation. The recipient must have been an Associate Member and not more than 30 years of age at the time his paper was presented to the Society. The award is in the form of an engrossed certificate accompanied by an honorarium of $50.

Previous award winners have included Wilbur W. Reaser for his paper on the "Calculation of the Heat Loss from an Airplane Cabin"; Martin Goland for his paper, "The Influence of the Shape and Rigidity of an Elastic Inclusion on the Transverse Flexure of Thin Plates"; Harry H. Hauger who presented "Thermal Anti-Icing of the Eagle Airfoil"; and Harry I. Ansoff for "Stability of Linear Oscillating Systems With Constant Time Lag."

The most recent award winner was John B. Nichols for his presentation, "An Energy Basis for Comparison of Performance of Combustion."

Nominations for recipients of this award will be welcomed from any member or group of the Society such as the various organized committees, divisional, regional, and sectional organizations.

Between now and the Annual Meeting of 1958, it is contemplated that papers on aviation subjects will be presented during the 1956 Annual Meeting in New York, the 1957 Summer Meeting in San Francisco, and the 1957 Annual Meeting in New York, the Aviation Division Conference in the spring of 1958, and the 1958 Annual Meeting.

Those interested in becoming eligible for nomination should submit papers directly to Headquarters, ASME, 29 West 39th Street, New York 18, N. Y. All papers will be reviewed and presentation will be arranged at one of the scheduled aviation meetings.

Granville M. Read, Mem. ASME, chief engineer, E. I. du Pont de Nemours & Company, Inc.

American Engineers

By Granville M. Read[3]

We frequently say we live in a great country. When engineers review the past and scan the horizon for the future, might it not be well to consider why our country is great?

Only 464 years ago America was just a wilderness. Columbus discovered it by accident while boldly seeking a short cut to Asia. He solved the riddle of his time by proving the world is round—and much larger than anyone thought it was in his day. But he failed to return to Spain with silks and spices and gold of the East Indies—the treasures he had hoped to lay at the feet of Queen Isabella.

Columbus never knew that the continent he discovered would yield treasures of the spirit infinitely more precious than the luxuries he sought for his Queen. The wilderness that was America attracted wave after wave of the downtrodden people of the Old World. They fled from the yoke of oppression because they saw in this new land an opportunity to establish a society dedicated to freedom, equality of opportunity, and the dignity of the individual human being. They fought for these treasures from Bunker Hill to Iwo Jima, and Americans today stand alert watch around the periphery of the Iron Curtain to preserve them. For these guarantees—these ideals—provided the incentive and inspiration for carving out of the wilderness, in less than five centuries, the richest, happiest, and most powerful nation the world has ever seen.

God-given Rights

As engineers who march in the vanguard of progress, we should be first in appreciation of our God-given rights. We are free to choose our careers and our employers, worship as we please, live where we please, speak our minds, make our own friends, indulge in our own hobbies. Consequently, we, as a people, control our own destinies. The scientist and engineer are encouraged to strike out boldly, secure in the knowledge that initiative and innovation will be rewarded. By coupling technology with an increasing recognition of the humanities of life, we have created unprecedented opportunities and have developed a concept of civilization so new and challenging that at times we seem lost in a maze of scientific and cultural enigmas.

Consider the contributions of the engineer to our material welfare under this stimulus of freedom. The average American wakes up in a home comfortably heated by electricity, gas, oil, or even by solar energy. He finds hot and cold running water in a modern bathroom and probably shaves with an electric razor. His breakfast is prepared on a gas or electric range with automatic controls. His household contains literally hundreds of mechanical and electrical appliances which save labor and make life easier.

No longer is it necessary to live close to a place of work. There are rapid transit facilities, the private automobile, or perhaps even the private airplane, to place a home in the suburbs within reach of nearly everyone. Business transactions can be carried on by telephone, teletype, telegram, or radio and wives can reach their husbands at the office by merely dialing a number. There is no need for heavy woolens in winter or perspiration in summer—light, thin clothing may be appropriate the year around in air-conditioned offices and homes. An infinite variety of natural and synthetic materials provide nearly ideal floors, roofs, walls, lighting, soundproofing, heat insulation, clothing, and furniture.

When the average American returns home from work, he finds an array of modern communication—books, magazines, newspapers, radio, television, and recordings—to keep him in touch with what goes on in the world. For recreation, there are golf courses, tennis courts, fishing, hunting, and gardening—and a 500-mile trip over a week-end is just a mere jaunt.

The average American is free to participate in politics, in school affairs, and other civic activities. Many engineers are active in technical societies, as well as in community affairs, charities, church affairs, educational work, men's clubs, and similar activities.

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[1] Westinghouse Electric Corp., Radio-Television Division, Metuchen, N. J.

[2] Stanford Research Institute, Washington, D. C. Mem. ASME.

[3] Chief Engineer E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Mem. ASME.

Every engineer takes part in maintaining and improving this environment of the average American. The individual engineer's work may be general or highly specialized. You may find yourself working on commercial projects, or in the field of national defense, such as atomic energy or guided missiles or jet engines. You may construct municipal waterworks or power plants. You may design the machines and buildings for our factories which provide needed jobs and turn out needed products at costs within the reach of all.

The Engineer and the Farmer

The engineer has joined hands with the farmer to bring modern technology to the production of agricultural products. This has transferred manual labor from the shoulders of the farmer to mechanical equipment, thereby producing more food with less labor and providing the farmer with the same conveniences as enjoyed by his city brother.

Whatever your task, you are making a daily contribution to our better way of life.

The skills and knowledge required for a professional engineer are not easily mastered and require many years of academic training followed by years of practical experience. In the past 100 years, the record shows that the engineer has served well in peace and war, always alert to disregard tradition for new and modern ways and concepts.

You and I are American engineers. As Americans, let us always be on guard to help preserve our priceless heritage of individual freedom and opportunity. As engineers, however diverse our fields of specialization, let us be ever mindful of our common professional aim—the well-being of humanity. With diligence, sincerity, and skill, let us build on the firm foundation prepared for us by those who have gone before.

Actions of ASME Council at Semi-Annual Meeting, Cleveland, Ohio, June 16 and 18, 1956

The Council met in three sessions during the Semi-Annual Meeting of the Society in the Statler Hotel, Cleveland, Ohio, on Saturday, June 16, 1956, at 1:30 p.m., adjourning at 4:35 p.m., and at 8:00 p.m., adjourning at 10:00 p.m.; and on Monday, June 18, at 9:30 a.m., adjourning at 10:15 a.m. In addition, the Council met in executive session on June 16 at 4:45 p. m., adjourning at 6:00 p.m.

There were present: Council: President Joseph W. Barker; Past-President D. W. R. Morgan; Vice-Presidents W. H. Byrne, C. E. Crede, J. B. Jones, B. T. McMinn, F. W. Miller, A. C. Pasini, C. H. Shumaker, B. G. Elliott; Directors: E. O. Bergman, F. L. Bradley, H. C. R. Carlson, R. L. Goetzenberger, G. A. Hawkins, R. B. Lea, Joseph Pope, and J. F. Downie Smith; Past-Presidents: E. G. Bailey, H. V. Coes, E. W. O'Brien (Monday morning only), and A. A. Potter (Saturday afternoon); Assistant Treasurer E. J. Kates and Secretary C. E. Davies. Chairmen and Members of Boards and Committees: Constitution and By-Laws Committee, F. L. Schwartz (Saturday evening and Monday morning); Board on Honors, J. S. Morehouse (Saturday afternoon and Monday morning); Meetings Committee, J. H. Davis (Monday morning only); Board on Membership, W. H. Larkin (Monday morning only); Nominating Committee, A. T. Kniffen (Saturday afternoon and evening); Organization Committee, G. M. Muschamp (Saturday afternoon and evening); and Board on Technology, R. H. Bacon (Monday morning only). Reginal Delegates (Monday morning only): J. R. Aikens, W. E. Belcher, J. R. Blizard, D. B. Chenoweth, R. G. Critz, T. R. DuBois, L. M. Edwards, Harold Grasse, Gordon Hahn, A. H. Hines, Jr., R. L. Hollaway, Jr., J. C. Jefferds, Jr., A. H. Jensen, R. M. Kuhns, J. W. Little, G. R. Lord, J. R. Muenger, L. K. Mundth, H. B. Parker, John Parmakian, J. C. Whitehurst. Staff: O. B. Schier, 2nd, assistant secretary; T. A. Marshall, assistant secretary; G. A. Stetson, editor; Ernest Hartford, consultant (Saturday afternoon and evening); and J. J. Jaklitsch, Jr., associate editor.

The President reported a telegram from Past-President Warren H. McBryde, extending cordial California greetings and best wishes to the Society and all the ASME members in attendance for a successful Semi-Annual Meeting and a cordial welcome to San Francisco in June, 1957.

Development Fund Financial Statement. The Executive Committee, on Oct 20, 1954, authorized the Seventy-Fifth Anniversary Committee to proceed with the preparation of a special ASME motion picture, made an appropriation from the Development Fund for the purpose, and authorized steps to replenish the fund. In view of the time elapsed, and the apparent need to reinforce the previous action, the Council voted to authorize the President to appoint a committee to conduct a campaign to replenish the Development Fund according to plans and policies developed by the Committee. President Barker assigned this task to the Committee on Society Income which was appointed on May 4, 1956.

Bureau of Internal Revenue—Unrelated Business Income. The President advised the Council that an Internal Revenue agent from the District Director's Office had in reviewing recent tax returns of the Society raised the question whether the Society's gross income from its publications subjected the Society to Federal income tax on income from an unrelated business under Section 511 of the 1954 Internal Revenue Code. He reported that the officers of the Society had consulted with its counsel and accountants with respect to this matter and presented counsel's recommendations as to the procedure to be followed in opposing a claim for any such tax. After discussion, upon motion duly made and seconded, it was unanimously resolved that the Secretary oppose any assertion of a claim for taxes against the Society as outlined by the President, and that the officers of the Society be—and they hereby are—authorized and directed to take all such action (including such court proceedings as may be required) and to execute all such instruments (including a power of attorney to counsel to represent the Society before the Treasury Department and to appear in behalf of the Society) in connection therewith as such officers shall deem necessary or advisable.

Policies and Budget, 1956–1957. The Council voted to approve the policies and the budget for 1956–1957.

Procedures for Honors. The Special Committee on the Review of Procedures for Honors, which was appointed by the Council in November, 1954, "to review the policies and procedures followed by the Society in selecting recipients for honors, and to recommend any changes considered desirable," submitted its final report and the Council voted to accept the report with sincere thanks, to authorize the Secretary to carry out the recommendations which follow, and to discharge the Committee with an expression of appreciation for its painstaking work on this problem.

Further to implement the Report the Council voted:

(*a*) To approve for inclusion in the Honors Manual:

Assignment by the Board on Honors of a group of members from the Medals Committee to each of the honors, except Honorary Members and the ASME Medal, with the responsibility of seeking, screening, and nominating candidates to the Board on Honors:

Revision of principle 4 (*d*) to read: "A nominee for an honor may be renominated for that honor for two additional years, if not elected, and then removed from the list for at least three years. The name may be nominated at any time for another honor for which it has not been nominated during the past three years . . . ."

No selection, ordinarily, to be made for any one of the honors for contribution-to-literature, unless at least five papers are available for consideration.

(*b*) To authorize the Board on Honors to take the necessary steps to increase the amounts of cash prizes for the spirit of St. Louis Junior Award, Junior Award, Undergraduate Award, and the Postgraduate Award, where the deed of gift permits.

(*c*) To refer in the future, Deeds of Gift to the Board on Honors for review and recommendation as to suitability of terms, form of honor, and cost of administration before a gift is formally accepted by the Council.

(*d*) To request the Secretary, subject to review by the proper committee, to add a member to the staff to supervise the many details relating to the work of the Board on Honors, the Medals Committee, and Joint Honors.

Constitution and By-Laws Committee. The Council voted to adopt amendment to Article B5, Par. 13 (Fees and Dues), which received first reading Nov. 13–14, 1955.

The Council received for first reading proposed amendments to the following By-Laws:

Articles B3, Pars. 1 and 2 (Membership); B4, Pars. 1, 3–8 (Qualifications for Admission); B5, Par. 1 (Fees and Dues); B6A, Pars. 16, 16-A, 16-B, 16-C, 18-C (Boards and Committees); B6B, Pars. 2, 9, 10 (Society Representation); and N7, Pars. 1, 2, 3, 4–23 (Election of Officers and Directors).

Amendments to the following Rules were adopted: Articles R4, Rule 7 (Qualifications for Admission); R5, Rules 2,3,4,5 (Fees and Dues); and R8, Rules 1 and 2 (Secretary's Office).

Stephen Timoshenko Medal. The Executive Committee, on Dec. 2, 1955, approved the plan of the Applied Mechanics Division of establishing a Medal in honor of Stephen Timoshenko. The Applied Mechanics Division submitted its deed of gift to the council, which voted to refer the Deed of Gift of the Stephen Timoshenko Medal to the Board on Honors for consultation with the Applied Mechanics Division.

Holley Medal. It was voted to defer the award of the Holley Medal this year because the Holley Medal Fund is in arrears to the Society for approximately $700, and to request the Executive Committee at the end of the year to determine whether this deficit can be made up from current net income, the award to be placed on a biennial basis if the deficit is made up.

Manual on Practice for Consulting Engineers. Joseph Pope, chairman of the ASME Committee on Professional Practice of Consulting Engineering, presented a suggested revision of the Society's Manual on Practice for Consulting Engineers which had been prepared by the ASME Subcommittee working with representatives of the American Society of Civil Engineers and the American Institute of Consulting Engineers. Mr. Pope pointed out that there was an immediate need for this Manual which was the reason for its presentation at this time. He reported, however, that consideration is being given to a Manual in which a number of societies will co-operate, which may be issued under the auspices of Engineers Joint Council. It was voted to approve the 1956 revision of the Manual on Practice for Consulting Engineers for immediate publication and sale for the information and guidance of members of The American Society of Mechanical Engineers and clients, pending availability of a Manual acceptable to a wider group of engineering societies, including the ASME.

Upon Mr. Pope's nomination, the Council voted to appoint George Schobinger to serve as alternate to William F. Ryan on the EJC-ECPD Joint Committee on Practice of Engineering.

Seventy-Fifth Anniversary. J. H. Davis, chairman of the Seventy-Fifth Anniversary Committee, submitted the final report of that committee in bound form. The bound copy includes a complete set of the minutes of the committee, the budget, a compilation of the actual cost of the Anniversary, which amounted to about $57,000, and samples of the material issued in connection with it.

In making his report Mr. Davis paid tribute to the support of the staff under the leadership of T. A. Marshall, Jr.

The final report of the Seventy-Fifth Anniversary Committee was accepted with appreciation for its outstanding and splendid work in connection with the 75th anniversary of the Society, and the Committee was discharged with sincerest thanks.

Engineers Joint Council. E. J. Kates, vice-president of Engineers Joint Council, made an oral report summarizing the actions of EJC as they were contained in the minutes of the Directors and the Executive Committee of EJC. His remarks were supplemented by several members of the Council who served as representatives and alternates on EJC.

Upon recommendation of Engineers Joint Council, the Council approved the application of the American Society of Heating and Air-Conditioning Engineers to become a constituent member of EJC with the understanding that the financial assessment shall be based on the applicant's total dues income.

Annual Meeting, 1956. The Council considered the general arrangements for the Council during the 1956 Annual Meeting and expressed a preference for the scheduling of the first Council meeting on Saturday morning, November 24.

Mexico Section. Upon recommendation of Vice-President C. H. Shumaker, the Council voted to authorize the Mexico Section to send two delegates to the Regional Administrative Committee meeting and to modify the budget policy to provide that each delegate would receive 60 per cent of his mileage allowance while traveling in Mexico and 100 per cent while traveling in the United States; and that no change be made in the present formula for payment of dues by members in the Mexico Section.

Assignment of Counties. Upon recommendation of the vice-presidents, the Council authorized the assignments of territories as indicated: Toledo Section—Counties Allen, Crawford, Hardin, Huron. Dayton Section—Counties Anglaize, Logan. Schenectady Section—Counties Clinton, Essex, Warren. Syracuse Section—Counties Hamilton, St. Lawrence, Franklin.

Tarrant County Subsection. Upon recommendation of the vice-presidents, on June 17, 1956, the Council authorized the establishment of the Tarrant County Subsection of the North Texas Section to consist of Tarrant County in Texas with Fort Worth as meeting headquarters.

Baton Rouge Group. Upon recommendation of the vice-presidents, the Council authorized the establishment of the Baton Rouge Group of the New Orleans Section, the territory to include all the parishes of: East Baton Rouge, West Baton Rouge, Pointe Coupee, Iberville, Ascension, Livingston, St. Helena, East Feliciana, and West Feliciana, with headquarters in Baton Rouge.

Central Kansas Subsection. Upon recommendation of the vice-presidents, the Council authorized Section status for the Central Kansas Subsection with meeting headquarters in Wichita, Kan., and boundaries as follows: On north, State line between Kansas and Nebraska; on south, State line between Kansas and Oklahoma; on west, State line between Kansas and Colorado; and on east, Eastern county lines of Republic, Cloud, Ottawa, Dickinson, Morris, Lyon, Greenwood, Elk, and Chautauqua counties.

Richmond Area Subsection. Upon recommendation of Vice-President J. B. Jones, the Council authorized the establishment of the Richmond Area Sub-section of the Virginia Section, the territory to include the following counties: Stafford, King George, Spotsylvania, Caroline, King William, Hanover, Goochland, Powhatan, Henrico, Chesterfield, Amelia, Nottoway, Dinwiddie, Prince George, Surrey, Sussex, Southampton, Greenville, and Brunswick. The meeting headquarters will be in Richmond, Va.

Travel Expense for Faculty Advisers. Upon recommendation of the vice-presidents, the Council authorized the payment of travel allotment to each Faculty Adviser to attend the Regional Student Conference, provided that he requests such payment in advance; and requested the Finance Committee to reconsider the $2700 budget allowance for Faculty Advisers' travel in 1956–1957 in view of the sum expended for this purpose in 1955–1956.

Depositories at Student Branches. Upon recommendation of the vice-presidents, the Council voted that the policy for depositories at colleges having ASME Student Branches be modified so that the bound volume of Transactions can be sent free of charge to college depositories when requested by the head of the Mechanical Engineering Department.

Student Member Program. O. B. Schier, 2nd, assistant secretary, presented a 13-item Student Member program with the recommendations of the vice-presidents.

Item 1 dealt with the change of the name of the Student Branch, with which the vice-presidents did not agree. They, in turn, made an alternate recommendation that the Student Branch be called a Section, but to be identified by the name of the college at which the Student Branch was located. The Council approved the recommendation that the Student Branch be called a Section, but to be identified by the name of the college at which the Student Branch is located, and to refer this to the Constitution and By-Laws Committee for proper action, and approved the remaining 12 items of the Student Member Program. It also voted to establish the dues for Student Members as $5 per year in the fall of 1956.

Aviation Division. Upon recommendation of the Aviation Division, the Council approved the reactivation of the Custodian Fund of the Aviation Division to provide a repository of certain funds collected in connection with the activities of the Division, especially the Aviation Division Conference.

Certificates of Award. Certificates of Award were granted to the following retiring chairmen of Sections: Anthracite-Lehigh Valley, Homer F. Hatfield; Baltimore, Frederick J. Jeffers; Central Savannah River Area, C. R. Jones; Chicago, J. N. Wognum; and Virginia, F. R. Ceravich.

Certificates of Award were granted to the following retiring members of the Nominating Committee: H. B. Atherton, *chairman*, T. N. Graser, *secretary*, R. N. Benjamin, S. G. Eskin, L. E. Herbert, H. A. Johnson, A. T. Kniffen, R. W. Mills, H. N. Muller, Jr., J. W. Putt, and F. S. G. Williams.

New Engineering Societies Building. E. G. Bailey, ASME representative on the Task

Committee on the New Engineering Societies Building, stated that the report of that Committee would be available for distribution to the members of the Boards of the five societies concerned on June 22 and that it would be released for publication on June 27. He asked that the Task Committee be advised as soon as this Society takes formal action on the recommendations contained in the report. A statement covering the report of the Task Committee and its recommendations appears on page 773.—Editor.

Theodore von Karman. The Secretary reported that the Institute of the Aeronautical Sciences had arranged a dinner celebration on Theodore von Karman's 75th birthday in Los Angeles on June 20, at which Floyd T. Hague represented the ASME. Mr. Hague presented official greetings to Dr. von Karman on behalf of the Society.

Elmer A. Sperry Award. The Secretary reported that the 1956 Elmer A. Sperry Award was conferred upon Donald Douglas, president of the Douglas Aircraft Co., Inc., Santa Monica Calif.

Kelvin Gold Medal. The Kelvin Gold Medal for 1956, nominations for which are solicited from the Society, has been awarded to Sir John Cockcroft.

Harvey Mack. The Council noted with sincere regret the death of Harvey Mack of the Mack Printing Company, Easton, Pa., on May 29, 1956. The Secretary was asked to convey the sympathy of the Council to Mrs. Mack.

1956 Regional Delegates Conference. At the meeting of the Council on June 18, Gordon Hahn, Speaker of the 1956 Regional Delegates Conference, presented the recommendations of the Conference on June 17–18, 1956. The Council voted to express sincere appreciation to the Regional Delegates for their splendid work, to receive the report, and to refer the recommendations to the committees concerned for report to the council.

Executive Session of Council

The members of the Council met in executive session on Saturday, June 16, 1956, at 4:45 p.m., adjourning at 6:00 p.m. The President requested Frank L. Bradley to serve as Recorder.

The following members were present: President Joseph W. Barker; Vice-Presidents: W. H. Byrne, C. E. Crede, B. G. Elliott, J. B. Jones, B. T. McMinn, F. W. Miller, A. C. Pasini, C. H. Shumaker; Directors: E. O. Bergman, F. L. Bradley, H. C. R. Carlson, R. L. Goetzenberger, G. A. Hawkins, R. B. Lea, Joseph Pope, and J. F. Downie Smith.

Election of Honorary Members. Upon recommendation of the Board on Honors, the Council elected the following Honorary Members of the Society: Charles W. E. Clarke, Philadelphia, Pa.; William Francis Gibbs, New York, N. Y.; and Solomon C. Hollister, Ithaca, N. Y.

1956 Honors and Awards. Upon recommendation of the Board on Honors, the Council voted to approve the following honors and awards for 1956:

ASME Medal to Harry F. Vickers, Mem. ASME, President, Sperry Rand Corporation, New York, N. Y., "for pioneering in industrial oil hydraulics and for notable accomplishments in business leadership."

ASME George Westinghouse Gold Medal Award to Perry Walter Pratt, Mem. ASME, chief engineer, Pratt and Whitney Aircraft Division, United Aircraft Corporation, East Hartford, Conn., "for his eminent achievements in the field of aircraft propulsion; for his foresight, keen vision, and leadership in the development of the modern aircraft engine, where power concentration and efficiency beyond earlier dreams have been achieved."

Prime Movers Committee Award to: John Wistar Simpson, Mem. ASME, manager, Bettis Site, Atomic Power Division, Westinghouse Electric Corporation, Pittsburgh, Pa.; M. Shaw, nonmember, Reactor Development Division, U. S. Atomic Energy Commission, Washington 25, D. C.; Robert Baker Donworth, Mem. ASME, vice-president, engineering and construction, Duquesne Light Company, Pittsburgh, Pa.; W. J. Lyman, nonmember, vice-president of operations, Duquesne Light Company, Pittsburgh, Pa., I. H. Mandil, nonmember, Reactor Development Division, U. S. Atomic Energy Commission, Washington 25, D. C., and Nunzio J. Palladino, Mem. ASME, manager, PWR Reactor Design Subdivision, Atomic Power Division, Westinghouse Electric Corporation, Pittsburgh, Pa., for their paper "Description of the Pressurized Water Reactor (PWR) Plant at Shippingport, Pa."

Pi Tau Sigma Awards—

Richards Memorial Award to Everett McMullin Barber, Mem. ASME, Bacon Laboratories, The Texas Company, Beacon, N. Y., "for outstanding achievement in mechanical engineering within twenty to twenty-five years after graduation."

Pi Tau Sigma Gold Medal Award to John Alden Clark, Assoc. Mem. ASME, assistant professor, Massachusetts Institute of Technology, Cambridge, Mass., "for outstanding achievement in mechanical engineering within ten years after graduation."

Executive Committee of the Council

A special meeting of the Executive Committee of the Council was held in the rooms of the Society, July 3, to decide how to deal with the report of the Task Committee on the New Engineering Societies Center. There were present: Joseph W. Barker, chairman, F. L. Bradley, F. W. Miller, and A. C. Pasini of the Executive Committee; E. J. Kates, assistant treasurer, E. G. Bailey, past-president, W. H. Byrne, vice-president, Joseph Pope, director; C. E. Davies, secretary, D. C. A. Bosworth, T. A. Marshall, Jr., O. B. Schier, 2nd, assistant secretaries; and Ernest Hartford, consultant. Louis Polk, who did not attend, is in Europe.

Task Committee on New Engineering Societies Center. On June 22, 1956, a copy of the unanimous report of the Special Task Committee of the Founder Societies and the American Institute of Chemical Engineers on the location of the New Engineering Societies Center was mailed to each member of the Council. This report was released at noon on June 27, 1956, and is now a public document. (A statement covering the report of the Task Committee and its recommendations appears on page 773. Editor.)

Upon the invitation of the President, E. G. Bailey, one of the representatives of ASME on the Task Committee, also a member of the Task Committee Executive Committee, summarized the report and responded to the questions raised by those present.

The committee reviewed the letter ballot of the members of the Society which closed April 26, 1954, and which by a vote of 16279 to 939 approved "vesting in the Council the authority to decide for The American Society of Mechanical Engineers, at such time and place and in such manner as the Council may elect, such changes, if any, in Society headquarters' location as the Council may deem to be to the best interest of the Society and in keeping with its dignity and traditions."

The Executive Committee reached the conclusion that by this vote of the membership the Council had the authority to act on the report.

After discussion, the Executive Committee of the Council voted to approve the report and to recommend approval by the Council in a letter-ballot to close July 31, 1956.

The Executive Committee agreed that the ASME members should be kept in current touch with developments and Council actions on the program for the new Engineering Center through the pages of MECHANICAL ENGINEERING.

If the report is approved by the five Societies, large responsibilities devolve upon United Engineering Trustees, Inc., for the execution of the program. Accordingly, the Executive Committee of the Council voted to carry the New Engineering Center on the agenda as a regular item of business for the Executive Committee and the Council meetings, and to invite the presence of (1) the ASME representatives on UET, Inc.; (2) one or all of E. G. Bailey, James W. Parker, and James M. Todd (ASME representatives on the Task Committee); and (3) the two immediate past-presidents to attend these meetings to advise the Executive Committee and the Council in its actions on the Engineering Center program.

ASA Increase in Dues. At its meeting on May 4, 1956, the Executive Committee voted to approve the proposed amendments to the American Standards Association By-Laws revising the dues structure, subject to approval by the Board on Codes and Standards. On May 25, 1956, the Board on Codes and Standards approved the increase in ASA dues from $500 to $750 per organization representative. The Executive Committee of the Council voted to refer to the Finance Committee the increase in ASA dues per representative for consideration when the 1956–1957 budget is reviewed.

Henry Marx. The Secretary reported that Mr. Hartford and he had visited Henry Marx in Cincinnati, Ohio on June 26, 1956, and presented the greetings of the Council. Mr. Marx celebrated his 98th birthday on June 22, 1956, but goes to the office each day and is active mentally and physically.

Gantt Medal. The 1956 Gantt Medal was awarded to Henning W. Prentis, Jr., chairman of board, Armstrong Cork Company, Lancaster, Pa.

Appointments. Upon recommendation of the Organization Committee, the Executive Committee of the Council voted to approve the following appointments: Research Committee on Metal Processing, Carl J. Oxford, Jr., National Twist Drill & Tool Company, Rochester, Mich.; Power Test Code Committee No. 8 on Centrifugal Pumps, C. P. Kittredge, School of Engineering, Princeton University, Princeton, N. J., and John A. Delrich, research and development department, Worthington Corporation, Harrison, N. J.; Power Test Code Committee No. 19 on Instruments and Apparatus, W. G. McLean, Lafayette College, Easton, Pa., and R. J. Sweeney, consultant, Catasauqua, Pa.; Power Test Code Committee No. 26 on Governing Systems of Internal-Combustion Engine-Generator Units (organized to prepare a Test Code to meet the needs of the internal-combustion engine field; composed of members of SAE, AIEE, and ASME), L. J. Moulton, *chairman* (ASME), charge of diesel injector design, Marquette Metal Products Company, Division of Curtiss-Wright Corporation, Cleveland, Ohio; L. V. Bradnick (SAE), The Pierce Governor Company, Inc., P.O. Box 1000, Anderson, Ind., Robert Cramer, Jr. (ASME), Nordberg Manufacturing Company, Milwaukee, Wis., W. L. H. Doyle (ASME), Caterpillar Tractor Company, Peoria, Ill., Gilbert E. Erickson (SAE), International Harvester Compay, Melrose Park Works, Melrose, Park, Ill., N. R. Fletcher (ASME), Ebasco Services, Inc., New York, N. Y., L. B. Immele (NAPE), Burns & McDonnell Engineering Company, Kansas City, Mo., T. O. Kuivinen (SAE), The Cooper-Bessemer Corporation, Mount Vernon, Ohio, A. E. Marshall (AIEE), The Ready Power Company, Detroit Mich., George E. Parker, Woodward Governor Company, Rockford, Ill., T. V. Pedersen (SAE), Fairbanks, Morse & Company, Beloit, Wis., and E. R. Rutenber (SAE), Waukesha Motor Company, Waukesha, Wis.; U. S. National Committee of International Electrotechnical Commission, T. M. Robie (alternate for Paul Diserens); Alfred Noble Prize Joint Committee, Huber O. Croft dean, College of Engineering, University of Missouri (to replace L. E. Seeley to 1959).

ASA Award Committee for Howard Coonley Medal. The Executive Committee of the Council voted to appoint Albert S. Redway the ASME representative on the ASA Committee for Howard Coonley Medal for a three-year term.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph St.

Detroit
100 Farnsworth Ave.

San Francisco
57 Post St.

Men Available[1]

Mechanical Engineer, fluent German and French, 16 years' diversified experience in plant, piping, equipment design, tooling, heating, maintenance construction; wants responsible position. State details including salary range. ME-312.

Tool Engineer—Technical Writer, 22 years' experience as toolmaker, tool engineer, marine engineer, free-lance technical writer, instructor; instrumentation; 40. Retired naval officer. Desires, New England or South. ME-313.

Fire-Protection Engineer, BME, 32; seven years' experience in research and testing; supervising maintenance of installed fire-protection facilities, fire departments, and fire brigades; fire prevention inspection; PE license. Desires, New York metropolitan area. ME-314.

Engineering Manager, BSME; 43; 13 years' diversified experience as chief engineer in metal fabrication plus one year as chief engineer of Kraft paper mill. Desires position with opportunity for personal growth as a result of service to employer. Desires, Midwest. ME-315.

Plant Engineer; ME; PE license; 31; three years design and development; seven years supervision all-phases plant engineering, including development design-production equipment. Desires, New England, East, West. ME-316.

Dean or Department Head; MA; PhD; EE; 63; 20 years as department chairman, three years as dean. Electrical or industrial engineering. Desires, South, Southwest, or West. ME-317.

Chief Engineer, BME, ten years' industrial experience, to head department or assist top executive. Broad background in metal fabrication and ventilation. Strong administrator and organizer. Desires, metropolitan New York City or New England. ME-318.

Mechanical Engineer, ME, MS, 55; automatic machinery, five years; machine tools, eight years; sheet-metal presses, six years; good mathematician; gearing, cams, mechanisms; actual machine-shop experience; forging, heat-treating steels; intimate contact with pattern shop and foundry. Desires, Newark-N. Y., commutation. ME-319.

Executive or Staff Engineer, adept at old or new problems. Can administer group or assist top executive in mechanical and related fields based on 20 years of integrated design, development, research, and management. Wide coverage of light to heavy mechanical activities. Broad and progressive interests; registered, advanced degree. ME-320.

Executive-Product Engineer, BSME, MSIE; PE license, 30, one year teaching and research. Six years production engineering, scheduling, manufacturing, all types of machine and manufacturing operations. Tools and machinery. Extensive administration and sales development. Desires, N. J. or foreign. ME-321.

Inspection Engineer, 54; 18 years' inspection work, field and shop work, familiar with ASME/-APL Codes; 16 years' erection, operation and maintenance power plants, marine, stationary, and industrial plant maintenance. ME-322.

Mechanical Engineer, BSME, 45; six years lubrication engineer, 12 years machinery and equipment design, three years plant engineer equipment layout and design. Prefers Wis. or other North States. ME-323.

Engineer Economist, BSME; 46; over 20 years' background, economic evaluation, manufacturing cost studies, time study, methods and equipment design, plant surveys, cost estimating, production and plant-engineering license, statistics, and financial background. Prefers Midwest, West, Foreign. ME-324-531-Chicago.

Production Engineer, BSME, 30, seven years' experience in production planning and control; two years in teaching. Last four years as manager. Two years in own business as distributor. Excellent knowledge basic management techniques, applicable to any industry or business. Desires, East, Midwest, or West. ME-325.

Mechanical Engineer, 32, married, BME; PE; eight years' process-plant experience: equipment design, plant, and machinery layout, product packaging, materials-handling, maintenance. Tool and die design and machine-shop experience. Willing to relocate. ME-326.

Positions Available

Mechanical Engineer; graduate, 28–35, five to ten years' experience in steam and power generation, for industrial power-plant system. N. C. W-3107.

Industrial-Relations Representative, 24–32, degree desirable, three years' experience in the field of labor relations desired. Must have ability to deal effectively with both management, hourly and union representatives. Will work in labor-relations section on assignments such as servicing labor problems, developing written labor-relations policies, etc. Salary open. South. W-3571.

Production-Control Manager, under 45, college background essential, knowledge of all phases of modern scheduling and production-control techniques; at least two years' administrative experience on an executive level. Experience in the plastic insulated wire and cable field very desirable. Will be responsible for all production planning, scheduling, machine loading, etc. Salary open. Conn. W-3586.

Plant-Maintenance Engineer, graduate electrical, for electromanganese plant. Salary open. Tenn. W-3591.

Process Engineer, 30–40, preferably engineering degree, five to ten years' experience in operations or closely associated with the operation of a caustic chlorine or diaphragm cell plant. Will furnish advice on process design and selection of equipment for a new caustic chlorine plant. Salary open. West Coast. W-3596.

Sales Engineer, work in engineering on new lubricator and chemical-feeder applications as received from sales department. Should have mechanical as well as chemical-engineering knowledge. Drafting experience essential. Not less than ten years' experience on afore-mentioned items, or reasonably close items. Salary open. Buffalo, N. Y., area. W-3603.

Project Engineer, development and design of new products, encompassing lubricators, hydraulic equipment, automotive equipment, etc. Should be good designer willing to work on the board. Not less than 15 years' experience on drafting. Practical knowledge of hydraulics, mechanical devices, and general automotive equipment. Salary open. Buffalo, N. Y., area. W-3604.

Project-Design Engineer, 25–35, mechanical or electrical graduate, minimum of three years' experience with a company manufacturing low-capacity rotary or toggle switches, acting as a design engineer on this type of product. Duties will include design of low-capacity rotary switches, improvement of design of subminiature rotary switch now in production, etc. To start, $7500. Conn. W-3606.

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[1] All men listed hold some form of ASME membership.

Plant Engineer, BS(ME), minimum of five years' experience in the engineering field; two to three years' in maintenance and construction. Experience should be with chemical or allied fields. $7000–$8400. Northern N. J. W-3607.

Plant Engineer, BS(ME), about three years' experience in maintenance engineering and the ability to supervise small groups of men. Will be responsible for a wide variety of plant-engineering work such as steam-boiler-plant operation, electric-power transmission problems, electronic and pneumatic controls, machine design, compressed-air usage, and a number of different mechanical-design problems involving chemical as well as electrical and mechanical aspects. $6000–$8000. Central N. J. W-3608.

Project Engineer, 35–40, graduate mechanical, minimum of ten years' experience of which five years must be in the pulp and paper industry. Will be responsible for design of pulp and paper-mill projects for medium-sized engineering company. Must be thoroughly familiar with pulp and paper-mill processes and equipment and capable of supervising all phases of engineering. Should be familiar with construction technique and problems. Must be cost and time conscious. Salary open. East. W-3610.

Plant Engineer, minimum of BS in mechanical or electrical engineering, and at least five years' of plant-engineering experience in electrical or electronic manufacturing or equivalent. Will supervise and direct the activities of the plant-engineering department. $7488–$8844. Pa. W-3618.

General Superintendent, engineering degree or equivalent, several years' supervisory production experience in thermo products such as heat exchangers, evaporators, pressure vessels, steel pipe, etc., for chemical, power, and petroleum industries. $12,000–$15,000. Upstate N. Y. W-3634.

Instructor, BS in engineering, with or without teaching or industrial experience, to teach engineering drawing and descriptive geometry. $5000–$6000. New York, N. Y. W-3638.

Industrial Engineer, 26–30, with combination of chemical-engineering and industrial-engineering education and/or industrial background. A minimum of five years' varied experience desired. Duties will involve investigations culminating in full recommendations in all phases of chemical-mechanical processing operations; complete methods and production studies, departmental operations, material handling, etc. $7800–$10,800. Conn. W-3639.

Engineers. (*a*) Industrial engineer with manufacturing, accounting, and budgetary-control experience. $250 a week plus expenses. Duration, six months. Scandinavia. (*b*) Tool engineer with at least five years' supervisory tool-engineering and production experience covering turning, milling, broaching, grinding, and general machinery operations. $250–$300 a week plus expenses. Duration, six months. Spain. F-3641.

Industrial Engineers, experience in job evaluation, incentives, time studies, and methods improvement. (*a*) $8000–$10,000. Considerable traveling. Headquarters, New York, N. Y. (*b*) $250 a week plus expenses. Duration, six months. Location, Spain. F-3642.

Executive Engineer to assist engineering vice-president; MS (ME), or equivalent, with a practical knowledge of heat transfer, fluid flow, and dynamics of machinery. Executive administrative ability is important. $8000–$10,000. East. W-3644.

Sales Engineers, either graduate chemical or mechanical, who have had from one to five years' experience either in a chemical plant or as a salesman. Depending upon qualifications, training program would last from six months to three years during which time salary would be from $4500–$6000 a year; after assignment compensation would be salary-plus commission. Headquarters, Upstate N. Y. W-3646(*a*).

Industrial Engineer, about 30–40, graduate mechanical, industrial-engineering experience in a steel-fabricating operation. Will be responsible for liaison work, co-ordination and special projects; application of approved industrial-engineering policies and practices to improve operating performance, reduce waste and delays, etc. Activities will involve production methods, equipment layout, materials handling, and manpower, etc. $6000–$9000. Upstate N. Y. W-3648(*a*).

Utilities Engineer, BE or ME preferred, to 45, minimum of five years' in utilities-engineering work. Will be responsible for engineering problems connected with operations in maintenance of all plant utilities, i.e., steam, electric, oil, water, etc. Will also perform special staff assignments on the installation of capital equipment. $7200; company will pay expenses incurred for interview and relocation expenses. Will negotiate placement fee. Northern N. J. W-3654.

Assistant to Chief Designer, mechanical graduate, 28–45, several years' experience in the design of turbines, pumps, compressors, or similar equipment. Excellent opportunity for advancement. $7000–$9000, depending upon ability and experience. Conn. W-3656.

Equipment-Development Engineer, 30–45, at least two years' engineering plus eight to ten years' as a machine designer necessary. Under direction of the director of equipment development, will be responsible for the development of special equipment for food-processing industry. $7200–$8500. East. W-3660.

Staff Maintenance-Control Engineer, 28–35, mechanical graduate, or possibly an industrial-engineering degree with strong mechanical experience. Duties will involve the development and installation of maintenance-control program in several plants. Excellent opportunity as this is a newly created program. $6800–$8400. N. J. W-3661.

Cost Engineer, 30–45, graduate mechanical, experience in projects and cost. Under direction, will maintain a check on expenditures for authorized projects and compare expenditures with appropriations for effective cost control. $7000–$8500. N. J. W-3662.

Mechanical Engineers. (*a*) Design engineer, 28–36, graduate, for the investigation and planning of new equipment installations, including the preparation of the project, the development of engineering design, preparation of specs., project requisitions, and installation of new equipment. Salary: from two to five years' experience, $7200–$8400; from five to ten years' experience, $8400–$9500. (*b*) Project engineer, 30–45, graduate, some previous experience as a project engineer, to supervise and direct the preparation and execution of engineering studies and projects. $11,000–$13,500. N. J. W-3663.

Engineers: (*a*) Manager of product development to design, develop, change, improve, improvise, substitute, plan, direct, and supervise the development department of a company manufacturing nonferrous metal parts and assemblies. Will direct and supervise the making of all models. Must understand patent papers, drawing, claims, etc. Salary open. (*b*) Superintendent of automatic screw-machine operations, to supervise and co-ordinate the operations of the automatic screw machines. Must be experienced in automatic screw-machining operations, secondary operations, tooling, washing, inspecting, packing, and salvaging of automatic screw-machine work. Salary open. Conn. W-3668.

Engineers. (*a*) Mechanical engineers, 26–30, ME or nuclear-engineering degree, one year nuclear engineering and five years mechanical engineering, two of which must have been in machine design. Project-engineering activities will consist of technical design and testing relating to nuclear equipment-development work. "L" and "Q" security clearance required. $7280–$8840. (*c*) Mechanical engineers, graduates, eight to ten years' experience in mechanical engineering, at least five years' in design of automatic machinery. Work will include general project engineering with emphasis on the design of automatic machinery. Must be capable of following design from conception to completion and testing. $7800. Conn. W-3672.

Assistant Plant Engineer, 30–40, graduate mechanical, to assist chief engineer in equipment selection and installation, air-conditioning pumps, drying ovens, etc., for a chemical plant. $7500–$9000. New York, N. Y. W-3679.

Production Engineer, graduate mechanical, three to five years' production experience. Should have potential administrative and supervisory abilities and be primarily interested in production and manufacturing. Salary open. New England. W-3683.

Machine-Design and Development Engineer, BS or MS in mechanical engineering, and at least five years' experience in machine design in a manufacturing concern. Must have good knowledge of the principles of machine design, mathematics, strength of materials, and mechanics. Salary open. New England. W-3684.

Plant Manager, managerial, production, and industrial-engineering experience in textile fields covering cutting, sewing, finishing, and packaging. $12,000. Pa. W-3688.

Manufacturing Engineers. (*a*) Senior manufacturing engineer, graduate mechanical or industrial, minimum of five years' manufacturing-engineering experience, some of which must be in sheet-metal fabrication. Will have responsibility for technical operation of major area or product groups within manufacturing division. Will review product design to determine optimum design for manufacturing; determine manufacturing method for new product; tool and die design and procurement; machine and equipment procurement; methods inspection; cost-reduction analysis; installation, tryout, and approval of projects. (*b*) Intermediate manufacturing engineer, graduate mechanical or industrial, three to five years' experience in tooling and methods work. Will assist senior manufacturing engineers in solving production problems. Detailed planning concerning methods, tooling, and plant layout. Estimate costs; develop methods to reduce manufacturing costs. (*c*) Junior manufacturing engineer, graduate mechanical or industrial, no experience required. After one year of on-the-job training in manufacturing engineering, will assist intermediate and senior manufacturing engineers in solving production problems including tooling, methods, plant layout and equipment, and machinery procurement. From $4800–$10,000. Midwest. W-3692.

Development Engineer, graduate mechanical, four to ten years' manufacturing processing; to conceive, develop, and evaluate production processes for installation in the production department. Must be able to represent effectively the company in its relationships with outside contractors. $7200–$9600. Company will pay one half of placement fee when applicant reports for work; the other half after six months' employment. Will pay traveling expenses for interviews; moving expenses are negotiable. Pa. W-3695(*a*).

Engineers. (*a*) Methods and procedures engineer, industrial engineering, production department, graduate industrial or mechanical, five to ten years' experience in methods and procedures, to make production-cost reductions by intensive application of methods, work measurements, and procedures analysis; study work flow and make plant layouts; measure and document effectiveness of cost-reduction activity. $7200–$9000. (*b*) Testing engineer, quality control, BS in metallurgical or mechanical engineering, five years' experience in mechanical metallurgy and mechanical testing of metals to establish testing methods to quality audit control of titanium products; troubleshoot internal and customer testing problems; supervise quality control physical testing group, etc. $5700–$8160. Company will pay one half of placement fee when applicant reports for work; the other half after six months employment. Will pay traveling expenses for interviews; moving expenses are negotiable. Pa. W-3696.

Teaching Personnel. Assistant professor to teach mechanics and resistance of materials. MS in mechanical engineering and industrial and/or teaching experience. Salary open. (*c*) Instructor to teach mechanical drawing, descriptive geometry, mechanics; i.e., applied mechanics and machine design as a basic interest. BS (ME) and experience required. MS and experience preferred. Salary open. Positions available September, 1956. Middle East. F-3707.

Tool and Methods Engineer, at least five years in tooling and methods work; know metal fabrication and machine operations. Will do tooling and methods work in operations department of railroad. To $9000. East. C-5131.

Designer, mechanical, civil, or chemical graduate, to 40, at least three years' in cement-mill design or allied industry; must know cement and concrete manufacturing. Will understudy company consultant on cement-mill design and construction for an engineering and contracting company. $8000–$8400. Employer will pay fee. Chicago, Ill. C-5134.

Instructor or Associate Professor, mechanical or civil, to teach undergraduate classes in civil or mechanical-engineering subjects, including supervising laboratory phases. $4800–$6000. Nev. C-5136.

Assistant Head of Aviation Department, aeronautical or mechanical graduate, 35–40, at least three years in aviation instrumentation and/or oxygen systems. Will design and develop pneumatic instruments and controls, oxygen systems, and similar apparatus for a manufacturer of gases. $6000–$8000. Employer will negotiate fee. Mo. C-5156.

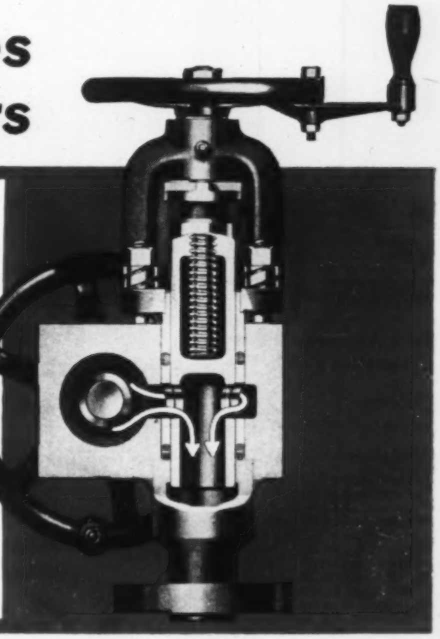
Operations-Analysis Research, mathematics, to 45, at least four years' experience. Duties will include operational research and analysis problems in the solution of interceptor problems. Must be U. S. citizen and clearable by the F.B.I. for electronics research. $10,000. Employer will negotiate fee. Ohio. C-5164.

Chief Engineer, to 50, experience in guided missiles, drones, or aircraft instrumentation. Will be in charge of research and development on guided-

(*ASME News continued on page 796*)

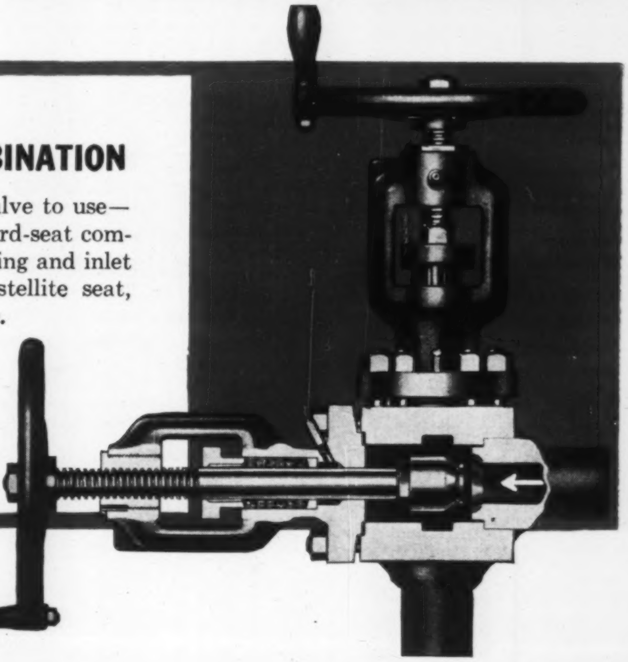
UNIT TANDEM

rugged blow-off valves for high pressure boilers



HARD-SEAT—SEATLESS COMBINATION

■ For boilers up to 1500 psi, this Yarway Unit Tandem Blow-Off Valve offers the maximum in dependable service. A one-piece forged steel block serves as the common body for the Yarway Stellite Hard-seat blowing valve and the Yarway Seatless sealing valve. All interconnecting flanges, bolts and gaskets are eliminated. The Unit Tandem at right is sectioned through Seatless Valve to show balanced sliding plunger in open position and free flow.



HARD-SEAT—HARD-SEAT COMBINATION

■ For boilers to 2500 psi, this is the valve to use—Yarway's Unit Tandem Hard-seat—Hard-seat combination. Disc has welded-in stellite facing and inlet nozzle has integral welded-in heavy stellite seat, providing smooth, hard-wearing surface.

**OVER 4 OUT OF 5
HIGH PRESSURE PLANTS
USE YARWAY BLOW-OFF VALVES**

Write for Yarway Catalog B-434

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.
Branch Offices in Principal Cities

YARWAY BLOW-OFF VALVES

missile devices. Also need a project engineer to work under afore-mentioned. $7500–$12,000. Employer will negotiate fee. Western Chicago, Ill., suburb. C-5181.

Sales Engineer, printing presses, at least two years in sales or design of printing presses. Know graphic arts. Duties will involve sales of printing presses and stereotype equipment primarily to newspapers. Travel, but not over one week at a time; no car required. $6000–$12,000, plus expenses. Employer will pay fee. Chicago and other territories. C-5211.

Project Engineer, mechanical graduate, to 40, at least ten years' experience in general mechanical work for process industry. Will co-ordinate design, calculations, and specifications; may have some board work, for a miller of flour. $700–$800 a month. Employer will pay fee. Minn. C-5220.

Mechanical Designer, graduate, to 40, at least ten years' experience in mechanical design of production equipment in food plant; know conveyers and bulk-handling equipment. Will design conveyers, material handling, steam and power, and other mechanical equipment for a flour mill. $700–$800 a month. Employer will pay fee. Minn. C-5221.

Candidates for Membership and Transfer in ASME

The application of each of the candidates listed below is to be voted on after Aug. 24, 1956, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and ●Transfers

Alabama

Tidwell, Clarence A., Jr., Huntsville

California

Anthon, Erik W., El Cerrito
Bartholomew, Robert J., North Hollywood
●Bascom, Hollis H., Livermore
Boutchard, Lawrence R., Whittier
Box, William A., Los Angeles
Brunetto, James J., San Francisco
French, Albert F., Los Angeles
Gates, George M., Reseda
●Gradisar, Albin A., Los Altos
Grayman, Martin, Culver City
●MacPherson, John W., Glendale
Maurer, John P., Berkeley
Rogers, Thomas E., Lakeside
Siegel, Martin J., Los Angeles
Vail, Herbert P., San Francisco
Yoshida, Akira G., Los Angeles

Colorado

Paul, Ben E., Colorado Springs
Schuster, Jack C., Denver
Stafford, Richard C., Denver
Torpey, James R., Denver

Connecticut

Hunt, David H., Simsbury
●Schueler, F. William, Stratford

Delaware

Richardson, Wallace J., Wilmington

District of Columbia

Zegveld, Walter C. L., Washington

Florida

Goory, William J., Pensacola

Georgia

Baker, Charles T., Atlanta

Illinois

Drake, G. Forrest, Rockford
Fratamico, John A., Chicago
Hachat, Dorwin E., Chicago
Merry, Orval L., Hinsdale
Ramlow, William M., Decatur
Skallerup, Robert M., Chicago

Indiana

Hayes, Thomas P., Fort Wayne
Murphy, Francis J., New Haven
Updike, Stanley H., Indianapolis

Kansas

Dunn, John W., Wichita

Louisiana

Alley, Phillip G., Shreveport
●Batchelor, Aylmer P., Shreveport

Maryland

●French, Francis H., Baltimore

Massachusetts

Loening, Werner F. R., Wayland
Marsh, Wilson E., Boston
●Titterton, George E., Canton

Michigan

Blank, Leon, Ann Arbor
●Goodman, Leonard J., Rochester
Winzer, Hans D., Marinette

Missouri

Immele, Leonard B., Kansas City

Nebraska

Lobel, Harry, Omaha
Lundberg, Norman W., Omaha

New Jersey

●Levin, Herbert L., Paterson
Miller, Edgar H., Mt. Tabor
Ryan, Francis D., Livingston
Silvey, Charles W., Newark
●Steger, George W., Maywood
Steinmark, Leonard B., Newark
Thorp, Arthur G., 2nd Whippany

New Mexico

Harley, Edward L., Albuquerque
Quinlan, Robert E., Albuquerque

New York

Brandon, Ronald E., Schenectady
Gazis, Denos C., Jackson Heights
Hales, Kenneth A., Yonkers
●Miller, Edward H., Resford
Ocvirk, Fred W., Ithaca
Owczarek, Jerzy A., Schenectady
Philippbar, Frank W., New York
Ramos, Edmundo J., New York
●Spencer, Robert C., Jr., Scotia
Weilenmann, Henry J., Schenectady

Ohio

Golueke, Carl A., Dayton
Kurtz, Robert A., Toledo
●Louzecky, Paul J., Lakewood
●Manley, Robert F., Cleveland
Tubbesing, Richard L., Dayton

Pennsylvania

Bean, Richard L., Sharon
Blickley, George J., Feasterville
Carney, Joseph E., Marcus Hook
Czuszak, Charles C., Jeannette
●Erway, Charles A., Pittsburgh
Foster, James L., Jr., Laughlintown
Gardon, Robert, Pittsburgh
Hemeon, Wesley C. L., Pittsburgh
●Lais, Lucio, Reading
Marsilio, Dominic O., Philadelphia
●Pace, Anthony J., Philadelphia
Slysh, Paul, Elkins Park

Rhode Island

Russell, William C., Cranston
Welshman, James R., Providence
Zollinger, Alfred, Providence

South Dakota

●Roby, Raymond L., Mitchell

Tennessee

●Myers, Millard L., Oak Ridge

Texas

Crum, Royce L., Texas City
Funke, Harold D., Houston
Gober, Forrest, Baytown
Miles, Vernon H., Houston
Rushing, Alvin C., Lake Jackson

Vermont

Goodchild, Harry M., St. Johnsbury

Washington

●Dempsey, Allen J., Bellevue
●Hadley, Richard H., Seattle

West Virginia

Ryan, John D., Charleston

Wisconsin

Liebmann, John M., Madison
McCann, Walter L., Fond Du Lac
Woythal, Robert T., Milwaukee

Foreign

Abkin, Abraham, Haifa, Israel
Britton, John R., Honolulu, T. H.
Castillo-Vela, Ulpiano, Guanica, Puerto Rico
Hymmen, Edmond B., Galt, Ont., Canada
Lyder, Wilfred D., San Fernando, Trinidad, B.W.I.
Seiler, Harry, Hamilton, Ont., Canada
Vivian, William H., Fyzabad, Trinidad, B.W.I.

Transfers from Student Member to Associate Member 595

Obituaries

Herman F. Ball (1867-1955), president, Franklin Railway Supply Co., New York, N. Y., died Nov. 23, 1955. Born, Altoona, Pa., Dec. 17, 1867. Parents, Frederick S. and Lizetta (Griesen) Ball. Education, public schools and private tutors. Mem. ASME, 1913.

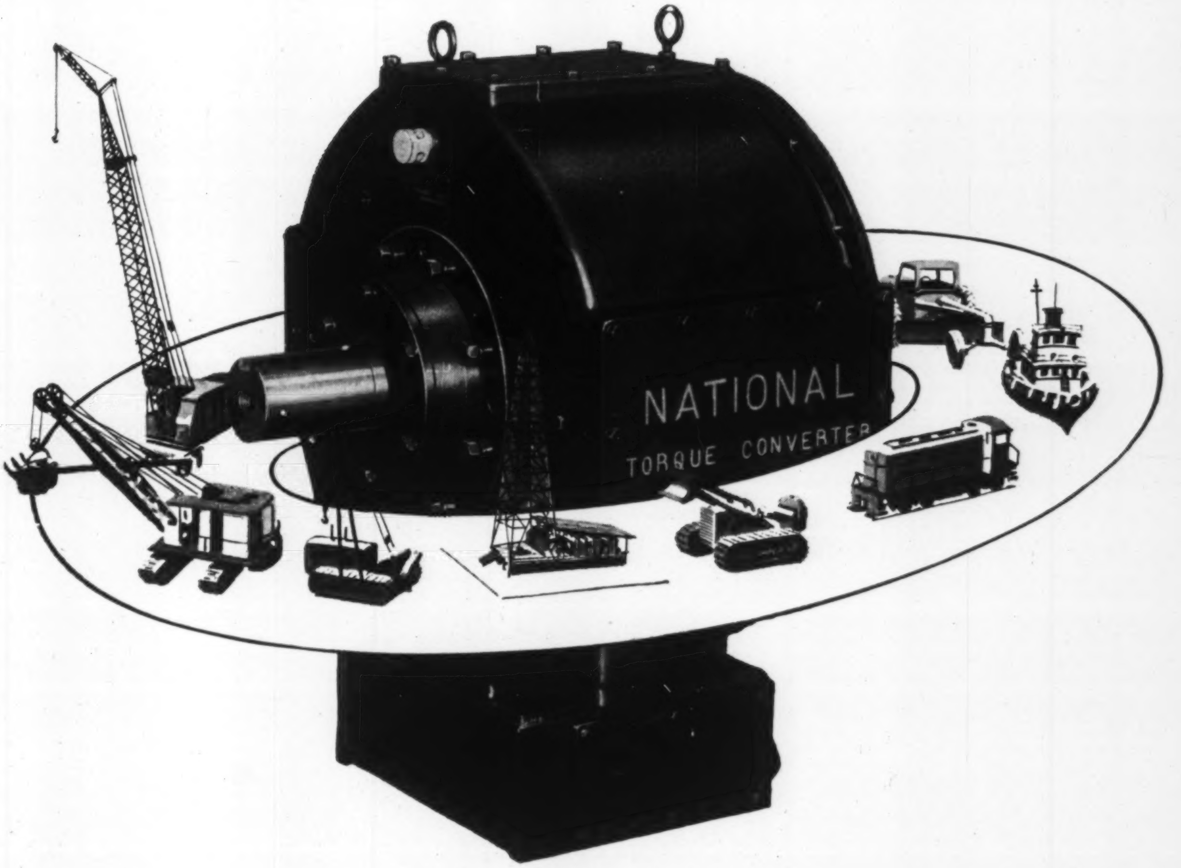
Cesare Barbieri (1877-1956), consulting engineer, Tuxedo Park, N. Y., died May 25, 1956, at Doctors Hospital, New York, N. Y. Born, Bologna, Italy, June 9, 1877. Parents, Enrico and Maria Barbieri. Education, professional school in Bologna, Italy, including four years of practical mechanical work, machine design, steam and gas-engine practice; additional study in Paris, France, and Berlin, Germany; (he came to the United States in 1905) BS(ME), Lewis Institute, 1914. In World War I he was an officer in the Engineers Corps of the Italian Army and was assigned to the Italian Military Mission in New York, N. Y. He became a member of the War Industries Board in Washington, D. C., and represented the Italian High Commissioner there. For this service he was decorated by the Italian Government. His studies and experience prepared him as a specialist in economic and industrial engineering. Mem. ASME, 1908. Naturalized U. S. citizen, New York, N. Y., 1929; later established the Cesare Barbieri Endowment which helped to restore the University of Bologna. Held over 100 U. S. Patents relating to industrial processes, special machines, and mechanical devices; also a number of patents in Great Britain and Canada.

John Livingston Bremmer (1903-1956), General Services Administrator, Public Building Service Division, General Services Administration, Kansas City, Mo., died April 3, 1956. Born, Enid, Okla., July 31, 1903. Parents, John A. and Lillie M. Bremmer. Education, BS(ME), Missouri School of Mines, 1928; postgraduate work in hydrostatics and water turbines. Married Helen Burford Scott, 1928; sons, James S. and John F. Mem. ASME, 1946.

Harry T. Brohl (1897-1956), steam superintendent, Eastern Engineering and Service Division, Westinghouse Electric Corp., New York, N. Y., died May 11, 1956. Born, Sandusky, Ohio, May 20, 1897. Parents, E. P. and Louisa

(ASME News continued on page 798)

●Transfer to Member or Affiliate.



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National Torque Converters are designed to help your equipment provide top performance where top performance is required . . . in strip mining, mechanized mining, drilling, earth moving, road building, load lifting and transportation, logging operations, and similar industrial applications . . . wherever Diesel or gas engines or electric motors are used.

The torque converter transmits engine power to the job in a steady, smooth flow. All the shock of quick starting and fast acceleration of the load is absorbed hydraulically by the torque converter. This enables the engine to attain its optimum speed quickly . . . without lugging or stalling . . . and to deliver its full horsepower constantly.

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INDUSTRIAL PRODUCTS DIVISION

Two Gateway Center, Pittsburgh 22, Pa.

Pace-setters in the progress of industrial power transmission

Brohl. Education, BSME, University of Michigan, 1920. Married Florence E. Raine, 1921; son, Harry T., Jr. Assoc-Mem. ASME, 1926; Mem. ASME, 1935.

Jay Anthony Freiday (1887-1956), retired mechanical engineer and designer of all types of mechanical equipment, died March 6, 1956, in Orange (N. J.) Memorial Hospital. Born, East Orange, N. J., July 31, 1887. Parents, Thomas and Emma Louise (Connors) Freiday. Education, Mechanics Institute, New York, N. Y.; 3 years, Polytechnic Institute of Brooklyn. Married Ida B. Reinhardt, 1909. Mem. ASME, 1920; Fellow ASME, 1951. Held several U. S. Patents pertaining to boilers and boiler parts. Author of technical papers relating to power plants, equipment, and piping, which were published in professional journals. Survived by wife; three sons, J. Horl, Chatham, N. J.; Donald H., Aiken, S. C.; and T. Roland, Fort Lauderdale, Fla.; and three grandchildren.

Emil Kumming (1883-1956), retired engineer of Webster Groves, Mo., died Jan. 15, 1956. Born, St. Louis, Mo., Jan 27, 1883. Education, public schools, St. Louis, Mo. Held patents on apparatus he designed for manufacture by the U. S. Mail Chute Equipment Co. Assoc-Mem. ASME, 1921; Mem. ASME, 1935.

John T. Nelsen (1922-1956), engineer, Western Union Telegraph Co., New York, N. Y., died March 12, 1956. Born, Brooklyn, N. Y., April 22, 1922. Parents, Nels and Christine (Johnsen) Nelsen. Education, ME Polytechnic Institute of Brooklyn, 1948. Married Joann Mulhearn, 1952. Jun. ASME, 1951. Survived by wife; three children, Robert A., Anita J., and Joan; and his mother.

Melvin Ovestrud (1889-1956), president, Pioneer Engineering Works, Inc., Minneapolis, Minn., died in February, 1956. Born, Spring Grove, Minn., March 17, 1889. Parents, Guel E. and Bergit (Sagdalen) Ovestrud. Education, BS(ME), University of Minnesota, 1913; ME, 1914. Married Ingebor Marie Bjoraker, 1918; children, Richard M., Margaret E. Jun. ASME, 1917; Mem. ASME, 1950. Held U. S. Patents on continuous heat-treating plant for 155-mm shells; continuous production plant for railway tie plates; portable aggregate crushing, screening, and washing plant; live-roller conveyer; bridge closure between main and eccentric bearings on any eccentric shaft; and a process patent for foundry-sand reclamation.

Bertram Hanson Saltzer (1901-1956), engineering recruiting and training administrator, Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J., died April 20, 1956. Born, Valley View, Pa., March 30, 1901. Parents, Harvey F. and Elizabeth M. (Artz) Saltzer. Education, BS(ME), Pennsylvania State College, 1923; ME, 1928. Married Florence Lucille Willson, 1924. Mem ASME, 1940. In 1940, before joining the Wright Aeronautical Division, he was a designer of tunnel blowers and ventilators for the Pennsylvania Turnpike Commission. Author of numerous technical papers published in professional journals. Survived by wife; a son, John H.; his father and brother, Ernest; and five half-sisters.

Charles Richard Smith (1872-1955), retired superintendent, Mechanical Division, American Appraisal Co., Milwaukee, Wis., died Dec. 21, 1955. Born Milwaukee, Wis., Aug 27, 1872. Parents, Henry and Christina Smith. Education, grade and high schools; studied law. Married Hattie Weilep, 1895. Married 2nd, Maude Thorburn, 1935. Assoc-Mem. ASME, 1918.

John Ransom Stone (1880-1952), chief mechanical service, U. S. Penitentiary Department of Justice, Leavenworth, Kan., died Aug. 8, 1952, according to a notice recently received at headquarters. Born, Fort Wayne, Ind., Nov. 16, 1880. Education, common schools; IAS electric-lighting and mechanical-drawing courses. Mem. ASME, 1919. He was a specialist in locking devices and mechanical designs pertaining to penal institutions.

James Martin Talbot (1883-1956), engineer and executive vice-president, S. S. White Dental Manufacturing Co., Princes Bay, Staten Island, N. Y., died April 23, 1956. Born, Newark, N. J., April 4, 1883. Parents, Andrews W. and Rosa E. (Martin) Talbot. Education, AB, Wesleyan University, 1906; ME, Massachusetts Institute of Technology, 1908; hon. LLD, Wagner College, 1949. Married Cornelia Best De Groff, 1909. Jun. ASME, 1913; Mem ASME, 1919. He was a founder and former treasurer of the Society for the Advancement of Management and was recipient of several national management awards. Survived by wife; two sons, John D., dean of the George School at Newton, Pa., and Robert L., Summit, N. J.; and seven grandchildren.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Division (no more than three) in which you are interested. Your membership card bears key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you are registered.

Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

Please complete the form below and mail it to: ASME, 29 West 39th Street, New York 18, N. Y.

- -

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Date

LAST NAME FIRST NAME MIDDLE NAME

POSITION TITLE NATURE OF WORK DONE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give complete name in full) Division, if any

* ☐ EMPLOYER'S ADDRESS City Zone State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

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☐ Transactions of the ASME	20th of preceding month
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☐ S—Power
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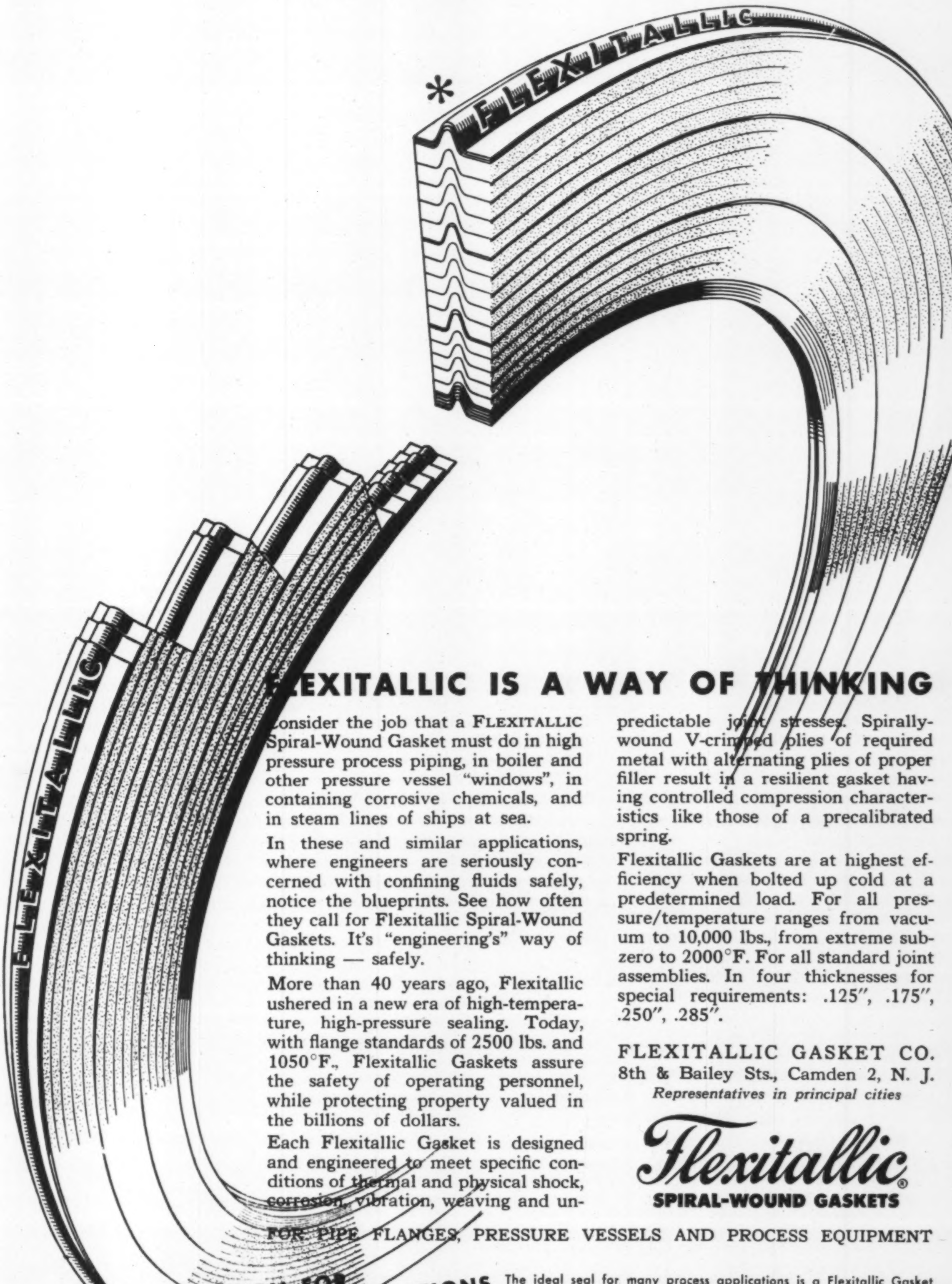

FLEXITALLIC IS A WAY OF THINKING

Consider the job that a **Flexitallic** Spiral-Wound Gasket must do in high pressure process piping, in boiler and other pressure vessel "windows", in containing corrosive chemicals, and in steam lines of ships at sea.

In these and similar applications, where engineers are seriously concerned with confining fluids safely, notice the blueprints. See how often they call for Flexitallic Spiral-Wound Gaskets. It's "engineering's" way of thinking — safely.

More than 40 years ago, Flexitallic ushered in a new era of high-temperature, high-pressure sealing. Today, with flange standards of 2500 lbs. and 1050°F., Flexitallic Gaskets assure the safety of operating personnel, while protecting property valued in the billions of dollars.

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having controlled compression characteristics like those of a precalibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme subzero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125″, .175″, .250″, .285″.

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SPIRAL-WOUND GASKETS

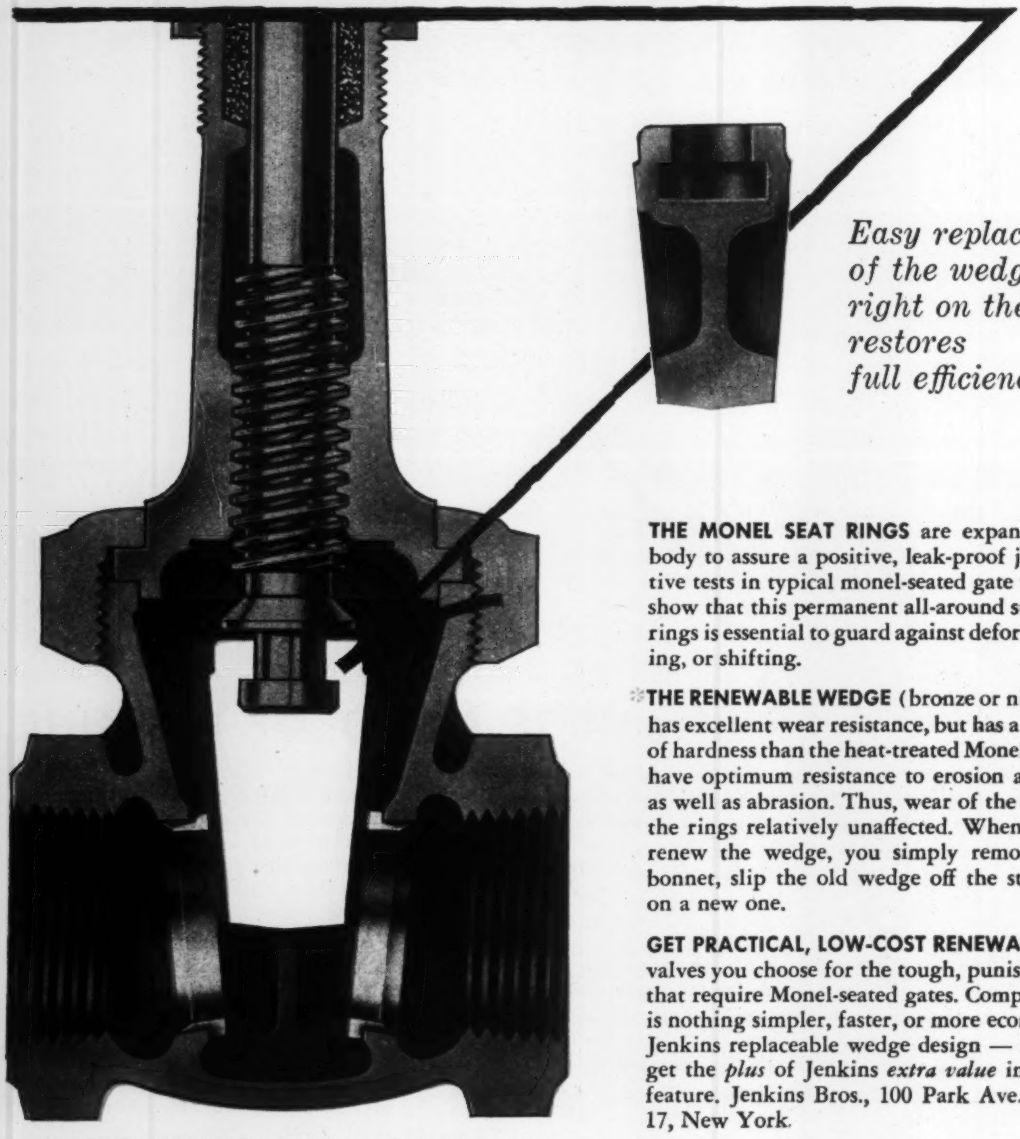
FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

TEFLON FOR PROCESS APPLICATIONS The ideal seal for many process applications is a Flexitallic Gasket with Teflon trapped between edges of stainless steel. Ask for folder, "Teflon in Flexitallic Gaskets."

*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue-dyed Canadian asbestos filler.

In JENKINS Monel-seated Bronze Gates

THE WEDGE* TAKES THE WEAR - *and spares the rings*



Easy replacement of the wedge only — right on the line — restores full efficiency

THE MONEL SEAT RINGS are expanded into the body to assure a positive, leak-proof joint. Exhaustive tests in typical monel-seated gate valve services show that this permanent all-around support of the rings is essential to guard against deforming, loosening, or shifting.

***THE RENEWABLE WEDGE** (bronze or nickel alloy) has excellent wear resistance, but has a lower degree of hardness than the heat-treated Monel rings, which have optimum resistance to erosion and corrosion as well as abrasion. Thus, wear of the wedge leaves the rings relatively unaffected. When necessary to renew the wedge, you simply remove the valve bonnet, slip the old wedge off the stem, and slip on a new one.

GET PRACTICAL, LOW-COST RENEWABILITY in the valves you choose for the tough, punishing services that require Monel-seated gates. Compare . . . there is nothing simpler, faster, or more economical than Jenkins replaceable wedge design — and you also get the *plus* of Jenkins *extra value* in every other feature. Jenkins Bros., 100 Park Ave., New York 17, New York.

***MADE WITH BRONZE OR NICKEL ALLOY WEDGE**

The bronze wedge provides lasting economy for most applications. The nickel alloy wedge provides extra resistance where rapid wear and corrosion are factors.

JENKINS BRONZE GATES WITH MONEL SEAT RINGS

200 psi	300 psi
Fig. 270-U, Bronze Wedge	Fig. 280-U, Bronze Wedge
Fig. 270-UN, Nickel Alloy Wedge	Fig. 280-UN, Nickel Alloy Wedge
Fig. 270-UL, Bronze Wedge, U.L. approved for L.P.G. Services	**350 psi** Fig. 280-UX, Bronze Wedge

JENKINS BRONZE GATES INCLUDE 40 DIFFERENT PATTERNS

125 • 150 • 200 • 300 • 350 psi SOLID WEDGE • SPLIT WEDGE
SCREWED • FLANGED • SOLDER END • SOCKET END QUICK OPENING

Call your local Jenkins Valve Distributor for complete information.

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VALVES
SINCE 1864
TRADE JENKINS MARK
Jenkins Bros

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Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING

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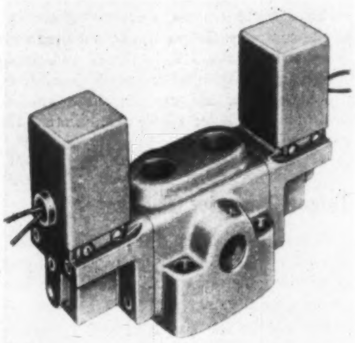


Hydraulic Cylinders

Logansport Machine Company, Inc., Logansport, Ind., announces a new line of hydraulic cylinders identified as the Super-Matic.

The units have pressures to 2000 psi and come in seven bore sizes, from $1^1/_2$ to 6 in. Maximum stroke is 72 in.

Five mounting styles—foot, trunnion, centerline, flange, pivot and manifold with interchanging covers to permit muliple mounting combinations are provided. Front and blind-end covers are of heavy steel plate, and piston rods of highly polished steel. They are available in either standard or heavy-duty size in both male and female. Cylinder tubes are hard-drawn and corrosion-resistant for low friction. Ports are unobstructed and can be relocated to any 90-degree position by rotating cylinder covers; tie rods are extra-heavy to maintain tension and resist shock loads. Cushioning is available for either or both cylinder ends as specified.

Steel Lock Nuts

Palnut Co., Glen Rd., Mountainside, N. J., announces the addition of a $^3/_8$ in.-16 size Acorn type nut to its present line. Acorn type Palnuts are spring steel lock nuts which exert a vibration proof locking action when tightened. The firm says they are light in weight, low in cost and available in plain steel, as well as cadmium, chrome, nickel, brass and dull black finishes. Free samples are available on request to the manufacturer.

Grinding Coolant Filters

Six filters with capacities of from 5 to 60 gpm for filtering heavily contaminated grinding machine coolants have been announced by Purolator Products, Inc., Rahway, N. J.

The accordion pleated, plastic impregnated filter elements trap particles down to a size of 10 microns. Capable of removing either ferrous or non-ferrous metal particles, the new filters are said to prevent scratching of parts being ground and provide protection for internal pump parts from metallic particles and abrasives.

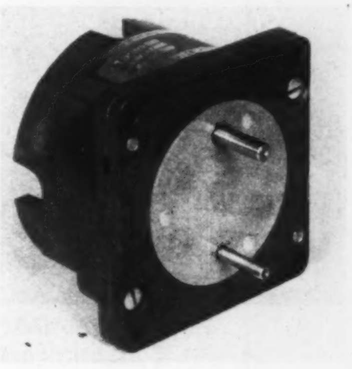
The easily replaceable elements, according to the firm, have an economical life while handling either water soluble oils or thread grinding compounds.

Giannini
875T
Giannini

Potentiometer

The development of a high temperature precision potentiometer rated to 200 C, has been announced by Electromechanical Div. of G. M. Giannini and Co., Inc., 918 E. Green St., Pasadena 1, Calif.

The new potentiometer, Model 875T, is a servo-mount sub-miniature single turn rotary precision unit with a power rating of 2 watts at 150 C. Despite its $^7/_8$ in. diameter, linearity is ±0.5 per cent or better, and resolution is as high as 0.06 per cent. Precious metals are utilized in the coil and wiper to permit low contact pressure and to provide long, noise-free life. Potentiometer coils can be supplied with taps, and as many as six sections can be ganged on a common shaft. Recommended by the company for applications requiring high power at elevated temperatures, the potentiometer has a precision ground stainless steel shaft mounted in ball bearings, and is encased in a machined, anodized aluminum housing.



Dual Gear Box

Link Aviation, Inc., Binghamton, N. Y., has added a new dual output gear box to its regular line of standard hi-precision gear boxes.

Available in a variety of ratio combinations, the gear box, Model 013, provides primary and secondary output shafts for use in servo systems where two constant ratio outputs are required. The firm says the Model 013 with its second output minimizes space consuming gear arrangements and in some instances completely eliminates a servo system which may otherwise be needed to provide the additional output.

The gear box is adaptable to scaling problems where two different operating speeds are required, or where one fast positioning speed and a slower speed are needed as in recorders. It may also be used where constant ratio is required between any two functions—minutes/seconds, hours/minutes, days/hours, the company declares.

Adapter kits are available to facilitate utilization of the dual output gear box with various standard servo motors.

Synthetic Mica

Synthetic mica is now available in quantity for industrial application, according to an announcement from Synthetic Mica Corp., a subsidiary of Mycalex Corp. of America.

Four forms of the material are currently offered: Synthamica 202, high quality, synthetic fluor-pholgopite mica in flake or powder form; No. 707, a bonded inorganic punching material, .005 to .100 in. in thickness; No. 727, flexible inorganic bonded material for creating formed parts to be heat cured; No. 807, reconstituted mica paper sheets with no binder.

LOVEJOY Power Transmission Equipment

Job-Rated for the Particular Load to Give Maximum Performance on Your Job

NON-LUBRICATED EASILY-ASSEMBLED **FLEXIBLE COUPLINGS**

Bores (max.)......5/16" to 9½"
O.D. ....⅝" to 21½"
Wt. ....½ oz. to 1500 lb.
H.P. ....1/20 to 3000
Torque (static)..1½ to 5100 ft.-lbs.

MAINTENANCE-FREE INSTANTLY-ADJUSTABLE **VARIABLE SPEED PULLEYS**

Bores (max.)......½" to 1⅜"
O.D. ....3" to 13⅝"
Belt Sizes........A to 2¾ TW
Speed Ratios.......1-1 to 8-1
H.P. (1750 rpm.).....⅙ to 15

ECONOMICALLY-PRICED INFINITELY-VARIABLE **SELECT-O-SPEED TRANSMISSIONS**

Controls . Lever or Hand Wheel
Belt Sizes............A to C
Speed Ratios.....1-1 to 10-1
H.P. (1750 rpm.)...½ to 7½

LIGHT-WEIGHT PRECISION-BUILT **UNIVERSAL JOINTS**

Bores.............⅛" to 2"
Hub Dia. ....½" to 4"
Static Torque 340 to 130700 in.-lbs.
H.P. (100 rpm.).....½ to 207

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High Vacuum Pumps

By using a radiator-cooled lubricating system instead of a watercooling system, Leiman Bros., Inc., 102 Christie St., Newark 5, N. J., offers two new high vacuum pumps producing vacuums of 24 to 29.9 in. Hg, with capacities of 15 to 40.8 cfm, for continuous operation 24 hours a day, at average temperatures of 140 F compared with 250 F for watercooled types.

The lower operating temperature is maintained by circulating pre-cooled SAE 30 lubricating oil through the pump. The firm says constant recirculation of the oil through the radiator maintains a constant low operating tempera ture that gives maximum lubricating effect, prevents carbonization of oil, increases its life and reduces maintenance. According to the company the pump can not overheat, volumetric efficiency is increased and pump speeds up to 800 rpm are made possible to provide greater air capacity in a smaller size pump. Cooler oil also eliminates the vapor problem.

Torque Converter Governor

Pierce Governor Co., Inc., Anderson, Ind., announces the release of a new series of governors designed specifically for torque converter applications.

The use of the simple flyball system in torque converter governors provides dependable and economical control of tailshaft speeds throughout a broad range in all types of applications, the firm states. Symmetrical in design, the governors are said to be readily adaptable to all converters having provisions for driving a governor directly, with a belt, or with a flexible cable.

Fastening Device

The development of a new fastening device especially designed for holding printed circuit cards in place in an assembly has been announced by the Camloc Fastener Corp., 40 Spring Valley Rd, Paramus, N. J.

The unit consists of a ball stud and two clips. The ball stud, which also serves as an attaching nut for the contact plug mounting, is made of low-carbon steel and the two clips are high-carbon steel, spring tempered to hold against approximately a 12-lb pull-off force. All parts are cadmium plated. In normal printed circuit application two fasteners would be used.

Because of many special requirements, only one stock size is offered in production quantities at this time. Overall length of production clips is 0.662 in.; width, 0.188 in. Two holes in each clip accommodate either screws or rivets and the clips are designed for use on 0.062 in. material. Production studs are .0188 in. between flats on the hexagonal base. Length from flat on the base to center of the ball is 0.281 in. Studs are held in place with a No. 4-40 NC 2B-threaded machine screw.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

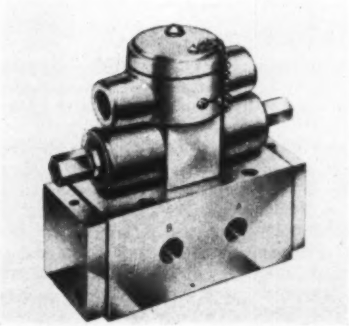
Spherical Bearings

Production of a new line of self-aligning plain spherical bearings for the commercial market is announced by Southwest Products Co., Duarte, Calif.

Patterned after the firm's "Monoball" self-aligning bearings, for aircraft and other critical installations, the new commercial bearings will be mass-produced with less costly materials and consequently will sell at a lower price range.

Called "SCB" and "SCBN" series, the new bearings are said to be the answer to many design problems. They reduce lost motion in linkages and withstand excessive vibration, and carry heavier loads than antifriction types since they have a greater surface supporting area, the firm states. Made of one-piece ball and one-piece race, they will take a greater radial and axial thrust load.

The bearings are available in sizes for $^3/_{16}$ in. bore to $1^7/_8$ in. bore, with capacities of radial ultimate static loads from 3000 to 152,700 lb.



Solenoid Air Valves

Hanna Engineering Wks., 1765 Elston Ave., Chicago 22, Ill., has announced the development of a new series of solenoid and master air valves. These valves are used for three- and four-way air operation, and are available in sizes of $^1/_4$, $^3/_8$, $^1/_2$, $^3/_4$ and 1 in.

The Flo-Line valves are used for controlling air cylinders and other air operated devices. Dependable performance, safe operation, easy maintenance and clean cut design are claimed to be the advantages offered by the valves.

Few moving parts and materials such as aluminum, brass and stainless steel were selected for lasting performance. The bubble tight aluminum spool is sealed positively by O-rings. Parts subject to wear are instantly replaceable without the possibility of assembling the valve incorrectly, the company states.

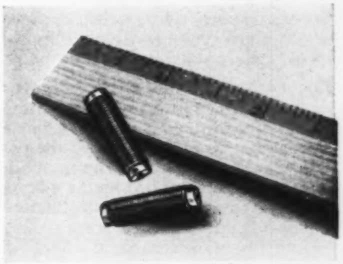
The solenoid valves have a built-in junction box. Coils meet the standards of Underwriters Laboratories. Bulletin 260 illustrating the valves is offered by the company.

Production News from Bridgeport Thermostat

FROM THIS ALL-NEW PLANT—
MORE AND BETTER BELLOWS

On its new 15-acre site at Milford, Conn., Bridgeport Thermostat now has 180,000 square feet of automated production facilities to assure quick delivery of all the bellows or bellows assemblies you need . . . at the lowest possible cost. A temperature and humidity controlled room for charging bellows assemblies is only one of the many ways in which this ultra-modern plant promises you bellows assemblies of consistently high quality.

¼" DIAMETER BELLOWS
Progress at Bridgeport is typified by this tiny bellows for miniaturization. Available in seamless design with a wide range of characteristics in brass, phosphor bronze, beryllium copper and monel. Larger sizes available.



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☐ Full details on small-diameter bellows.
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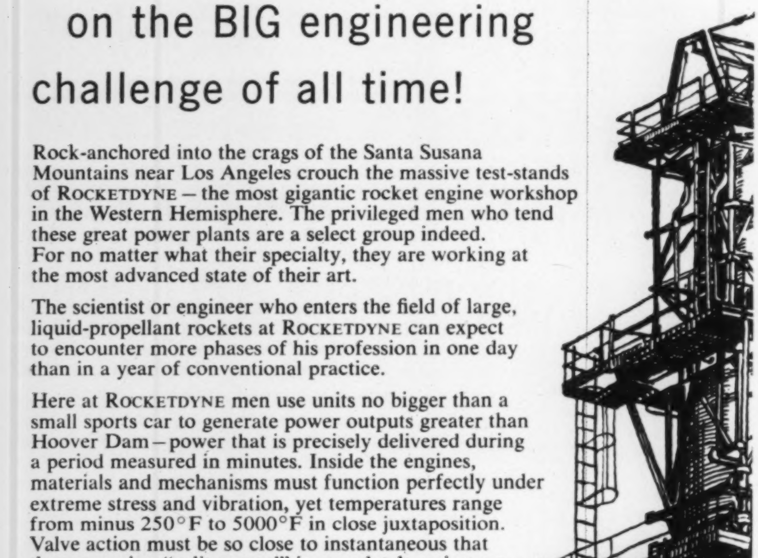
The scientist or engineer who enters the field of large, liquid-propellant rockets at ROCKETDYNE can expect to encounter more phases of his profession in one day than in a year of conventional practice.

Here at ROCKETDYNE men use units no bigger than a small sports car to generate power outputs greater than Hoover Dam – power that is precisely delivered during a period measured in minutes. Inside the engines, materials and mechanisms must function perfectly under extreme stress and vibration, yet temperatures range from minus 250°F to 5000°F in close juxtaposition. Valve action must be so close to instantaneous that the expression "split-second" is completely unimpressive; we are dealing with conditions in which the term "steady state" is applied to a millisecond.

Day by day the tests go on, and every day produces its two miles of information on oscillograph tape – fascinatingly new information, far in advance of available texts. This is one of the newer industries with an assured future. The methods now being developed here for producing effective power to the attainable limits of mechanical stress will have wide application. Such experience is practically unobtainable anywhere else.

The only way you can appreciate the far-reaching significance of such a program is to be a part of it. Will you accept the challenge?



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BUILDERS OF POWER FOR OUTER SPACE

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Glass Mat Laminates

A line of polyester resin glass mat laminates, having properties similar to the reinforced plastics used in sport car bodies is available from National Vulcanized Fibre Co., 1056 Beech St., Wilmington 99, Del. According to the company, advantages of these sheet laminates are their dimensional stability and exceptionally high impact strength, combined with above average arc resistance.

The properties of dimensional stability and impact strength suggest important uses in mechanical applications, such as fabricated containers and cams, the firm says. The new materials can also be used for armature slot wedges, spacers, switchboard panels and arc chutes, and their chemical resistance is said to make them useful materials in areas of high humidity and chemical fumes of an acid nature.

The company produces three standard grades of these laminates by impregnating glass fiber mats with a liquid polyester resin containing inorganic fillers and a catalyst. They heat cure the treated mats under low pressure to produce hard laminate.

15-Ton Press

Air-Hydraulics, Inc., 227 Belden St., Jackson, Mich., has announced it is in production of a low cost air hydraulic press with a rated capacity of 15 tons, increasing to 21 tons with line pressure of 100 lb.

Company officials state the C-500 model has a force in far greater proportion to its size (15 in. wide, 26$^3/_4$ in. deep, 40 in. high on 34 in. stand).

The company describes the new standard model as having a 8$^1/_4$-in. throat and delivering a 6-in. stroke at 10 cycles per minute. Other throat and stroke sizes are available. Three types of controls are offered—dual hand, foot pedal and fully automatic.

Dry Coupling Motor

A new fluid-drive principle, that of using steel shot instead of a true fluid, is provided by a new Flexi-Shaft motor, available from Reuland Electric Co., Alhambra, Calif. The coupling is mounted inside the motor's frame and the entire unit is supplied as a single-frame power package.

The motors are further available in the same power packages as the company's true fluid, Fluid-Shaft units. Many combinations with magnetic brakes and gear reducers can be supplied.

The dry-fluid coupling is an adaptation of the new Dodge Flexidyne drive. Its operating principle is based on centrifugal force throwing the steel shot to the perimeter of the housing. The housing, in turn, is keyed to the load and accelerates as the rotor gradually becomes "imbedded" in the tightly packed shot.

Flexi-Shaft motors are produced in ratings from $^1/_2$ hp through 15 h.p.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Vapor Condenser

Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y., announces the development of a vapor condenser in which the cooling is done by the evaporation of moisture on the surface of tubes through which the vapors pass.

Installed on the top of a stripping column or above a vacuum kettle, the apparatus is said to form a complete, self-contained condensing system. The heat is rejected from the coil surface directly to the outdoor air in a fan-induced air stream. The water sprayed over the coils is recirculated and the only water service required is for a small make-up.

Non-condensible gases are separated from the condensate by a baffle tube within the manifold into which the condensed liquid drains. All the condensate is recovered.

The non-condensibles are ejected by means of a steam ejector nozzle or vacuum pump. Before ejection they are effectively subcooled; thus the major portion of vapor mixed with such gases is condensed and returned through reflux tubes. Volume and weight of the non-condensible mixture ejected is therefore minimized.

Condensing temperatures within 20 deg of the atmospheric wet-bulb temperature are entirely practical, the firm says.

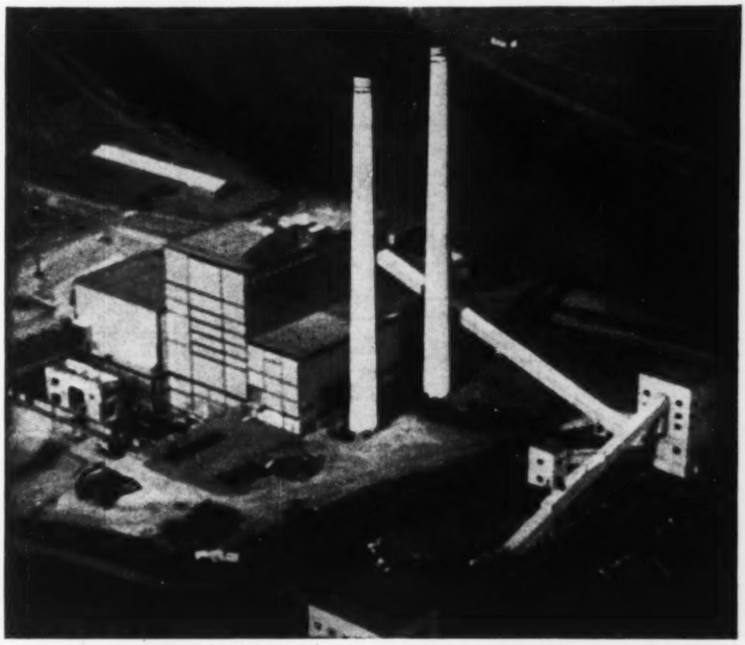
Vacuum Machine

Extra heavy-duty construction for long-term, low-maintenance operation is featured in a new Model P-905 vacuum machine introduced by the Premier Co., 755 Woodlawn Ave., St. Paul, Minn.

Designed for wet or dry pickup in industrial application, the Master-Vac unit has an average maximum water lift of 62 in. with the orifice closed; rated airflow capacity is 128 cfm. One thousand sq in. of filtering area and a specially-woven pleated filter cloth traps a maximum amount of dust with a minimum restriction of air flow, the company states. The filter need not be cleaned except when the machine is normally full, and an auxiliary, reusable paper filter is available.

Powered by a $1^1/_4$ hp motor, the unit operates off 115 volt a-c/d-c current supply. The company says the design of the machine permits cool air to be forced directly over the commutator by a separate matched ventilating fan instead of the conventional fan-compressed hot-air cooling. A specially designed seal on the lower motor bearing is designed to prevent water and dirt from entering the fan chamber.

The machine is $32^1/_4$ in., high, $21^1/_2$ in. in diameter and weighs 38 lb. Its steel tank holds 10 gal liquid or one bushel dry dirt. All bearings are of the permanently sealed variety. The machine is equipped with ball-bearing swivel-type casters, a 35 foot heavy-duty all rubber cord with UL listed plug and connection, and rubber-lined hose and adapter unit. Information from Dept. KP.



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Consolidated designs and builds chimneys of all types and all sizes—Perforated Radial Brick, Tapering Reinforced Concrete, Face and Common Brick, Acid Proof, High Temperature; installs linings for steel stacks, waterproofs, repairs and rebuilds, installs lightning rods and aircraft warnings; demolishes chimneys. Whatever your chimney problem may be, Consolidated has the experience, the knowledge and the skilled personnel to handle it.

Phone, wire or write today *for information. Ask for catalog giving installations, engineering service, chimney design data and specifications.*

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KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Production Lapping

Higher capacity, handling of larger parts and other desirable advantages in precision production lapping operations are said to be provided in a new 36-in. Model Lapmaster lapping machine available as part of the "John Crane" line ranging from 12 to 72 in. lap plate diameter.

Inside diameter of the conditioning rings is $14^{1}/_{2}$ in. The manufacturer states the machine will take well over twice as many 1 in. parts as the 24 in. model. The roller bar attachment has been designed to provide the operator with shelf space for placing pressure plates or fixtures.

The drain hole on the machine is on the side, and a wiper blade is fastened to the under side of the base table to bring all of the spent compound into the drain. A rubber hose, fastened to the drain plug, allows a container to be placed under the machine.

A fork style agitator is placed at a 30-deg angle in the agitator tank. This has been done to facilitate mixing of abrasive when left loaded in the tank for an overnight period. This eliminates strain on the agitator motors.

The lapping machines are capable of generating surface flatness to less than one light band and finishes to 2 rms in short or high production runs. They are designed for lapping of parts such as adding machines, engines, transmissions, cameras and projectors, tool and die equipment and quartz and germanium crystals. Materials include monel, steel, stellite, brass, aluminum, glass, carbon, plastics, ceramics and others.

The machines are manufactured by Crane Packing Co., Dept. MXN, 6400 Oakton St., Morton Grove, Ill.

Ratio Relay

Hagan Corp., 323 Fourth Ave., Pittsburgh 22, Pa., announces a new ratio relay for the pneumatic control field. Designated Model 3-15, it produces a true linear change in pneumatic output signal when using "suppressed" ranges such as 3-15 psi.

It is designed for adjusting the ratio between input and output signals in control systems such as fuel to air in combustion processes, ratio of gases in gas mixing and proportional feeding of chemicals.

The relay features true ratioing around 3 psig input and output bias pressures using a convenient handwheel for changing the ratio. Precision fulcrum drive assures exact ratio adjustment. The relay is compatible with any penumatic signal system having a range of pressures between 0 and 20 psi, the firm states.

Although primarily designed for use with 3-15 psig signals, an adjustment permits changing the minimum input and output bias values to any point between 0 and 6 psig. Maximum input and output signals may be at any value up to 20 psig. Details of the relay are contained in Specification Sheet SP-4315, available from the company.

Time Delay Valve

Airmatic Valves, Inc., 7313 Associate Ave., Cleveland, Ohio, announces a line of 2-way, 3-way and 4-way time delay valves.

The time delay valve provides delayed actuation with immediate reversal or immediate actuation and delayed reversal, according to the company.

Working on a volume principle, operating time of from 0 to 5 minutes delay may be accomplished by manual pre-set adjustment. Being pilot operated, these valves may be remotely located and controlled from a central station. They are available in standard pipe sizes $^1/_4$, $^3/_8$, $^1/_2$, $^3/_4$ in.

Infinitely Variable Transmission

A gear reducer with infinitely variable speed from true zero to the maximum of the unit is provided by building a gearhead into the output side of a fractional horsepower Zero-Max variable speed transmission according to a recent announcement by Revco, Inc., 1900 Lyndale Ave. S., Minneapolis, Minn.

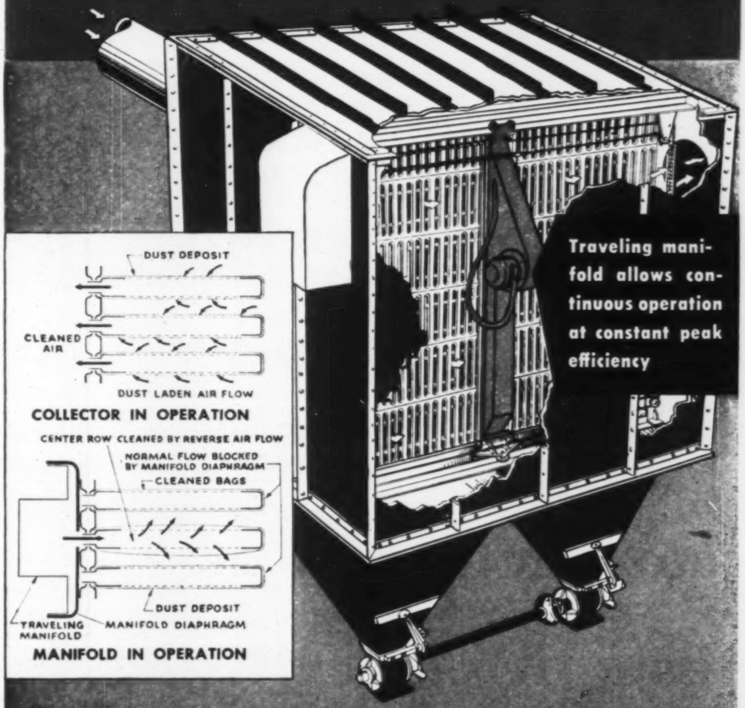
The infinitely variable speed is obtained through the transmission unit which has a range from true zero to $^1/_4$ the input speed. The firm says that because the gearhead input shaft is integral with the output shaft the speed of the gearhead output shaft is infinitely variable. Speeds can be changed instantly while the unit is running or stopped simply by moving the speed control lever on the unit. It is said that the unit develops constant torque with exceptionally accurate speed control.

Gear reductions of 2, 3, 4 and 5 to 1 that develop 20 to 100 in. lb of torque are available. Input and output shafts are parallel and the output shaft rotates counter clockwise on standard models. Clockwise operation is also available. Twenty-six models and types with various torque ratings and a variety of ranges of stepless speeds away from zero are available.

The output shaft is $^1/_2$ in. diameter with cartridge type oil seals. The entire unit, transmission and gearhead, runs in oil and may be mounted in any position.

NOW! Great news about a NEW Pangborn Dust Collector that

MAINTAINS CONSTANT OPERATING EFFICIENCY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MANIFOLD DIAPHRAGM
MANIFOLD IN OPERATION
Traveling manifold allows continuous operation at constant peak efficiency

New Pangborn Self-Cleaning Collector offers continuous automatic operation, constant air volume and suction, uniform air flow resistance at low cost.

TO MAINTAIN constant efficiency, the Pangborn Self-Cleaning Collector combines the proved efficiency of the cloth screen collector with continuous automatic operation.

A manifold with integral blower slowly traverses the clean air outlets of the screen frames. Covering three rows of screens at any given time, it applies a reverse air current through the center row to remove collected dust from the cloth surfaces. The result is constant high collecting efficiency and continuous operation—shutdown of the system for periodic cleaning is eliminated. Because of design simplicity and unit construction, this unique collector requires lower initial, operating and maintenance costs as well as less floor space than comparable collectors.

For full details, write for Bulletin 915 to PANGBORN CORP., 2200 Pangborn Blvd., Hagerstown, Md.

4D

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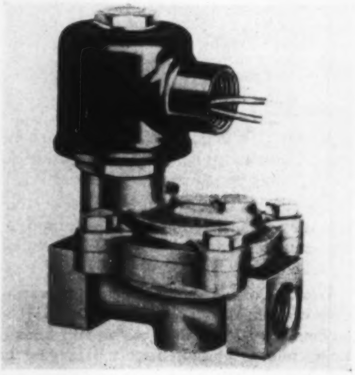
KEEP INFORMED | NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Radiation Detector

A new lightweight instrument, especially designed to detect and measure potentially hazardous atomic radiation in industry or x-rays in medicine is offered by the Electronics Div., Curtiss-Wright Corp., Carlstadt, N. J. Called the Radiameter, the unit weighs 2 lb, fits into a suit coat pocket, and operates on an ordinary flashlight battery.

The unit has been designed to fit the requirements of the health physicist, an entirely new class of scientist who directs the safe application of nuclear and x-radiation.



Solenoid Valve

A new diaphragm type solenoid valve designed especially to meet the need for an "off the shelf" multi-purpose valve is being produced by General Controls Co., Glendale, Calif.

Because of its diaphragm action and full flow ports, this new valve, known as the K-181, is said to be capable of handling large capacities with a minimum pressure drop, thus making it suitable for shutoff control of a large variety of liquids and gases over a wide range of operating pressures up to 250 psi.

Exceptional flexibility is attributed to the firm's multipoised design, a feature which provides for positive operation in any position, including side and inverted mountings.

The K-181 is available in $^{3}/_{8}$ and $^{1}/_{2}$ in. ips, and is offered in two basic models. Standard models handle a wide range of general applications using air, water, gases or light oils. Hot water models are particularly suited for controlling water at temperatures up to 200 F for use on coffee makers, hot chocolate machines, soup makers, laundry machines and various types of vending equipment.

All the valves are normally closed and feature forged brass bodies, packless construction, bubble-tight shutoff and two wire continuous duty solenoids having exceptionally long life. Valves are also available with optional waterproof coil, explosion-proof housing and manual opening device.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Speed Reducers

A line of helical speed reducers, developed to meet the need for heavy-duty, low-cost gear drives on conveyors, packaging machines and process installations where mounting flexibility is important, has been designed by Philadelphia Gear Works, "G" St., below Erie Ave., Philadelphia 34, Pa.

Eighteen different sizes of these new "IN-LINE" speed reducers (in single, double or triple reductions) are immediately available from stock. The units feature quiet, crown-shaved and induction-hardened helical gearing; oversize thrust bearings; extra-heavy steel shafts; large overhung load capacity; durable, cast-iron housings; positive oil bath lubrication for gears and bearings; two-way shaft seals to prevent oil leakage and protect gears and bearings from dust or dirt contamination. Backstops can be furnished with reducers, or installed in the field without further machining of housings.

All bearings, housings and gears are in conformance with AGMA specifications.

Units are available in reduction ratios from 1.25:1 to 205:1, and in horsepower capacities from 1 to 110. For installation in virtually any mounting position, these versatile units may be directly coupled, or driven from chain or belt drives on either the driver or driven shafts, or both.

Plastic Pumps

The Vanton Pump & Equipment Corp., Div. of Cooper Alloy Corp., Hillside, N. J., announces the availability of a Kel-F elastomer liner for use with their pumps.

The unusual chemical resistance of Kel-F permits the pumping of highly corrosive products under severe conditions, which heretofore could not be handled with existing materials. Pumps fitted with a Kel-F liner will find a broader use, either in the pilot plant, laboratory or production line. The proper selection of a pump body block, along with a Kel-F elastomer flexible liner, affords exceptional resistance to strong oxidizing acids, mineral acids, alkalies, aliphatic solvents, some chlorinated solvents, as well as various types of fuels and hydraulic fluids. The Kel-F elastomer liner also enables the pump to handle highly corrosive red fuming nitric acid. Pumps so fitted can be steam sterilized and operated at temperatures up to 300 F.

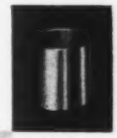
Due to the design of these pumps, which eliminates shaft seals and stuffing boxes, fluids or slurries are isolated to a passage formed by the outer surface of the flexible Kel-F liner and the inner surface of the body block made of Polyethylene, Buna N or stainless steel. Therefore, the fluid is in contact only with the block and the liner, with operation obtained by an eccentric shaft and rotor assembly rotating within the Kel-F liner and progressively pushing the fluid about its outer surface. Kel-F liners are currently available, in all pumps, in capacities from $^1/_3$ to 5 gpm.

time to re-examine

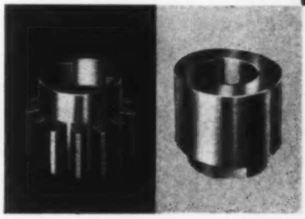
BEARING APPLICATIONS

Striking cost reductions in bearing applications in many mechanical products are made possible by the use of Bunting Sintered Powdered Metal Bearings and parts.

Bunting engineering counsel can guide you in the selection of designs and alloys that will provide bearings of exactly the type, design and material that will fully meet both cost and functional requirements, whether the material be Cast Bronze or Sintered Metal.



A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command comprehensive data and facts based on wide experience in the designing and use of cast bronze and Sintered Powdered Metal Bearings and parts.



Write to our Product Engineering Department in Toledo or consult our nearest Sales Engineer.

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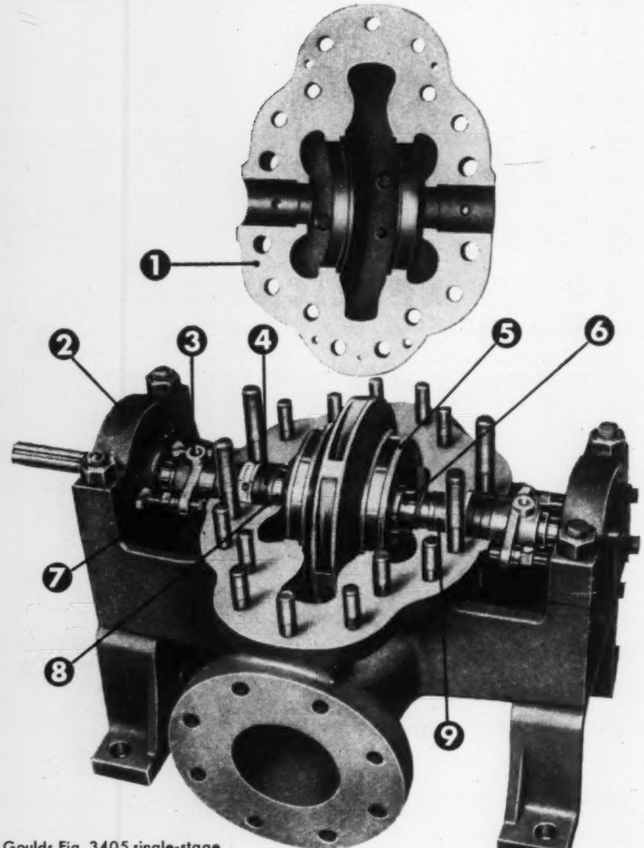

Goulds Fig. 3405 single-stage, double-suction centrifugal pump.

You get all 9 custom features at standard pump prices

1. You can inspect, clean, and remove the entire rotating element without disturbing piping or pump and driver alignment.

2. Moisture and dust can't get through sealed bearing housings.

3. You can use quenching fluids with these cowl-type glands.

4. Stuffing box packing is die-formed.

5. Impeller rings are stainless steel.

6. Unique locking of shaft sleeves allows change of rotation in field without additional parts.

7. Gland bolts are corrosion resistant.

8. Teflon water seal rings.

9. Highly desirable stuffing box bushings. Renewable.

Only the Goulds Fig. 3405 offers all these cost-cutting features at no extra charge.

33 sizes pump 200 to 6400 GPM at heads up to 425 ft. Single-stage. Double-suction. Interchangeable parts—you can cut spares inventory by $\frac{1}{2}$ or more.

Bulletin 721.6 gives performance data, specifications. Send for it.

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KEEP INFORMED | NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Shut-off Valves

Barksdale Valves announces a new line of shut-off valves for the control of oil from 0 to 3000 psi and air from 0 to 2000 psi, available in port sizes of $^1/_4$, $^3/_8$, $^1/_2$, $^3/_4$ and 1-in. NPT. These valves are capable of withstanding velocities up to 60 ft per sec without modification.

For ease and convenience in operation, the valve has a hand wheel with position indicator, opening and closing in a 90 deg turn, but may also be supplied with conventional handle. Provisions for panel mounting are included as standard.

This valve incorporates the "Shear-Seal" principle, which consists essentially of a pressure-balanced, self-aligning tubular sealing ring, the "Shear-Seal," in constant perfect contact with an optically flat porting disk or rotor containing the flow passage. This sealing principle has proven especially effective where critical leakage specifications must be maintained. Because flow is through the "Shear-Seal" and never across sealing surfaces, and because the square external corner of the "Shear-Seal" wipes the rotor clean, no dirt can enter between the sealing surfaces to cause scoring and destroy sealing qualities. With each actuation the seals actually lap themselves to a more perfect seal; the small amount lapped away after years of service is taken up by a back-up spring.

"Shear-Seal" valves are particularly suitable for throttling; the gradual opening or closing to any desired degree of flow, smoothly and without fighting the fluid pressure, because there are no spools or poppets to obstruct the flow.

For complete details write for bulletins A-5 and 0-5 to Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

Oil Coolers

Heat-X, Inc., Brewster, N. Y., has introduced a line of "WIO" oil coolers which have application on all types of diesel and gasoline engines, hydraulic equipment, air compressors, machine shop coolant systems and wherever oil must be efficiently cooled in a compact unit.

The new oil coolers feature inner-fin construction, a patented Heat-X design which permits more cooling in less space. The company points out that for any required capacity, this exclusive design means that a "WIO" oil cooler is the most compact unit made. Smaller size also means lower operating cost.

The coolers are of completely nonferrous construction, with brass shell and copper tubes. Units are available for operating pressures up to 250 psi and operating temperatures to 300 F.

An eight-page descriptive bulletin is available from the manufacturer.

Continued on Page 53

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NEW EQUIPMENT
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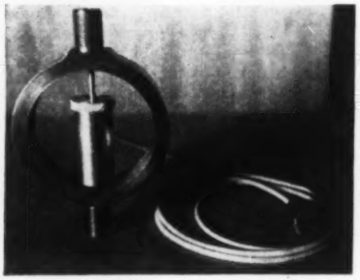
Self Reading Tape

A unique extension tape rule that permits instantaneous readings right from a dial is now available from Frederick Post Co., 3650 N. Avondale Ave., Chicago 18, Ill.

Called Rulo-Matic, the self-reading rule shows complete measurements to fractions of an inch, clearly read on a vernier dial. Upper graduations on dial shows $^1/_{16}$ in. fractions with main fractions on lower side. The triple coated white-face tape is counter balanced with an inner return spring. Oiling and cleaning pads are built in to clean and oil the blade each time it is used.

A small serrated steel wheel scriber is self contained in the case for marking measurements. Moveable end-clip on tape compensates for "butt" or "hook" measurements. The tapes are furnished in a die cast, highly polished chrome plated case and sell for $3.25 each.



Ring Load Transducer

A compact, easily operated proving ring dynamometer which is said to be a highly accurate, force-sensitive transducer for detecting static or dynamic forces has been developed by Schaevitz Engineering, Box 505, Camden 1, N. J.

The unit, type TDC-4, contains the firm's linear variable differential transformer and incorporates the features of the transformer for the remote detection of forces beyond the scope of ordinary mechanical, indicator-type proving rings.

Since the unit is electrical, response is instantaneous and precise, thus making it possible to control, measure and record with great accuracy a wide range of weights and tensile or compressive forces, the firm explains. A mechanical zero adjust is provided.

The type TDC-4 dynamometer can be obtained in ranges from 0–±50 lb up to 0–±10,000 lb. The output variation is completely stepless. Approximate full range output is 0.250 volts with 6.3 volts, 60 cps input. Departure from linearity is less than ±1.0 per cent of full range output. Other specifications include: ambient temperature range—between −65 and +220 F; hysteresis—less than 0.5 per cent; weight—between 0.50 lb for the 50 lb size and 2.5 lb for the 10,000 lb size.

Next Step...

Military airplanes powered by Pratt & Whitney Aircraft jet engines have repeatedly penetrated the sound barrier. Sixteen international airlines have ordered passenger planes, also to be powered by our jet engines, that will cruise at more than 550 miles per hour.

What will be the next step -- the next great break-through in aviation progress? The answer may be a nuclear aircraft engine that will permit a plane to circle and recircle the world without refueling.

Development of this A-engine offers tremendous challenge to the engineers and scientists who work on this project at Pratt & Whitney Aircraft. It gives them a unique opportunity to do creative thinking at, or beyond, the frontiers of current knowledge in all major technical fields. At the same time, it offers excellent possibilities for early professional recognition and advancement in one of America's growth companies.

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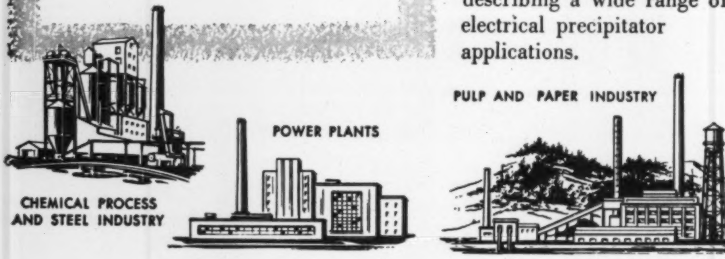

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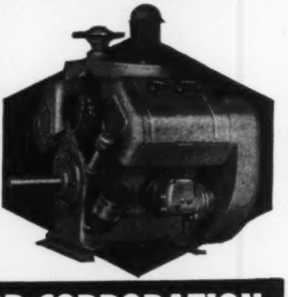
Write for Engine Specifications Bulletin S-188, and a copy of our complete list of approved service stations throughout the world.



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LATEST CATALOGS

Drain or Sampling Valve

Jerguson Gage & Valve Co. announces that the No. 23 drain or sampling valve originally available in $^3/_4$ and 1 in. sizes is now also available in standard sizes of $1^1/_4$, $1^1/_2$, and 2 in. NPT. The No. 23 is completely self draining and it is ideal for installations where it is desirable to have the valve seat inside the wall of a vessel to prevent liquid from remaining in the nipple and valve.

This is a rugged valve for severe operating conditions and it has the feature of outside screw and yoke construction for high temperature or corrosive operations where inside threads cannot be tolerated. The outside thread design eliminates possible freezing and allows the valve stem to work freely at all times. Foolproof operation is assured, the company claims, for the stem is constructed with a left-hand thread so the valve handle operates in the normal direction of standard valves.

The $^3/_4$ and 1-in. sizes are recommended for pressures of 4000 lb at 100 F and 1000 lb at 750 F; $1^1/_4$, $1^1/_2$ and 2-in. sizes are recommended for 600 lb at 100 F and 250 lb at 750 F. Standard materials are carbon steel body, stainless steel stem and Stellited seat. Also available in stainless steels, bronze and other special alloys to meet corrosive or other extreme conditions. Optional features include construction with additional outlet for such uses as a steaming out connection and with a reamer on the end of the stem to break away encrusted matter which may have collected on the inside vessel wall.

For complete details write Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.

Roll Bearings

Marlin-Rockwell Corp., Jamestown, N. Y., produces a line of ball bearings specifically for belt conveyor rolls. Experience in the conveyor field has led to development of design for both inboard and outboard mountings utilizing various types of seals, in synthetic rubber and cork-felt combinations, to hold grease in and keep dirt out.

Type CONV-3-J is an inboard design to mount directly into roller. This style is equipped with positive contact, oil-resistant synthetic rubber seals. The sealed-for-life feature in all M-R-C Conveyor Roll Bearings cuts both construction and maintanance costs.

Type CONV-3-SF is designed for simplified outboard mountings with milled slots in the outer ring which fit in U-shaped brackets in the conveyor frame. The metal shield, backed by impregnated felt and a spring controlled cork seal, retains the bearing lubricant and provides a very effective seal. All exposed surfaces are cadmium plated for resistance to corrosion.

M-R-C Conveyor Roll Bearings provide a simple and economical means of reducing friction in conveyor rolls with minimum operating cost.

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BUSINESS NOTES
LATEST CATALOGS

Simple Stroboscope

A stroboscope suitable for examination of moving machinery to demonstrating the principal of the stroboscope and for determining rpm, has been developed by Wabash Instruments and Specialties Co., Box 194, Wabash, Ind.

The flashing rate of the lamp can be adjusted from about 100 flashes per minute to nearly 4000 flashes per minute. The firm says the unit has a very simple electrical circuit. It may be used to determine the approximate speed or rpm of rotating objects by adjusting frequency of the flashes so that they synchronize with the moving part.

The Winsco stroboscope is mounted in a 6 × 6 × 6 in. black wrinkle finished case and equipped with a highly polished reflector. Calibrated dial, knob and switch are located on the side of the case.

Traction Fluid Drive

A new improved traction type Gyrol fluid drive for general industrial application is now available from American Blower Corp., Detroit 32, Mich.

Designated Size 126 Type T, the basic unit is designed for industrial use with internal combustion engines as a fluid power transmission for mobile material handling vehicles and construction equipment. Power rating in these applications is 25 to 85 hp, depending upon drive speed. When modified by installation of a flexible coupling half on each end of the fluid drive, the new unit is said to be well suited to constant speed electric motor applications for driving production and processing equipment, machine tools, conveyors and other material handling installations. As a motor driven unit, the Size 126 fluid drive is rated $7^1/_2$ to 15 hp for 1200 rpm drive speed and at 25 to 50 hp for 1800 rpm.

The new fluid drive is of die-formed, resistance-welded construction. The runner and impeller assemblies ride on two ball bearings which take the internal thrust of the unit, making the entire fluid drive a rigid assembly. Both bearings are readily accessible for inspection and maintenance.

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If you are interested in the challenge of the unknown, remember this:

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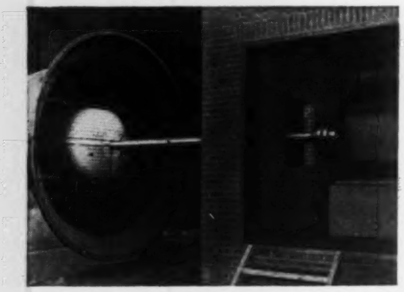
If you think you'd like to go along, contact J. M. Hollyday, Dept. ME-08, The Martin Company, Baltimore 3, Maryland.

MARTIN

Eliminate Intermediate Bearings !



By using Thomas Flexible Couplings on long, unsupported shafts, intermediate bearings are eliminated. Thomas engineers tubular shafts free from lateral whip.

The large fan shown above is 16′ from the motor to allow sufficient air intake. Miners working underground receive their fresh air supply from this fan and others like it, which have been giving dependable service for as long as fifteen years . . . without shutdowns for lubrication or maintenance of the couplings.

Thomas floating shaft flexible couplings are recommended for machine and marine drives, printing presses, paper and cement mills, cooling towers, diesel engines, pumps, compressors, and many other uses.

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3. Smooth Continuous Drive with Constant Rotational Velocity
4. Visual Inspection in Operation
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Thomas All Metal Couplings have No Wearing Parts so Lubrication and Maintenance are Eliminated

Write for Engineering Catalog 51A

THOMAS FLEXIBLE COUPLING CO.

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BUSINESS NOTES
LATEST CATALOGS

Brine Agitators

Ruthman Machinery Co., Cincinnati, Ohio, has announced new design features for its line of heavy duty brine agitators. The firm says the agitators now include unique, patented centrifugal and vapor seals.

According to the company, the new seals work on a basic centrifugal law to prevent the entry of liquid through the mounting flange and vapors cannot enter the motor and ball bearings. The seals do not require adjustment, maintenance or replacement because they operate on a centrifugal principal instead of metal-to-metal or other close contacts, the firm states.

The agitators are powered by totally enclosed fan-cooled motors, available in $^{3}/_{4}$ to 3 hp at 1200 rpm. Capacities are 380 to 2000 gpm at low pressure heads and in pipe sizes from 6 to 12 in. The agitator shaft is one piece stainless steel construction and rotates on two large precision ball bearings. The propeller and centrifugal seal are made of bronze. Bulletin 10502-A describes the agitator.

Resin Adhesive

A new one-part epoxy resin adhesive that provides exceptionally high shear strengths without the necessity of adding an accelerator or catalyst is now available from Adhesives and Coatings Div., Minnesota Mining and Mfg. Co., 423 Piquette Ave., Detroit 2, Mich.

Designated as EC-1386, the company claims this one part adhesive provides unlimited working life, a unique feature with adhesives of the epoxy resin type, and eliminates the difficulties sometimes associated with two-part adhesives such as short working life and the possibility of human error in mixing operations. Working life of two-part epoxy adhesives is usually limited to minutes.

This 100 per cent solids, liquid adhesive is designed for metal bonding over a service temperature range of −65 F to 250 F. It gives good adhesion to brass, steel as well as aluminum and can be used for industrial and aircraft applications where exceptionally high shear strengths at room temperatures and 180 F are required. No volatile by-products are given off during the curing cycle which makes it particularly useful for bonding impervious surfaces.

Adhesive EC-1386 offers good flexibility, considerably greater than most other epoxy resin type adhesives. This provides high strength bonds that have greater bending strength and greater resistance to cracking or shattering under shock or bend loads.

High strength bonds are obtained by curing this one part adhesive at temperatures in the range of 350 F. For example, average shear strengths of 4670 psi at room temperature and 4630 psi at 180 F are obtained on a $^{1}/_{2}$-in. 24ST3 alclad aluminum bond cured 60 min at 350 F under 25–50 psi pressure. The lowest recommended cure temperature is 330 F.

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The Laboratory is primarily concerned with research and development of guided missile systems. A sizeable program of fundamental research is concurrently in progress.

APL is responsible for technical direction of the Navy's Bumblebee guided missile program. Developments at APL include the first supersonic ramjet, and the missiles TERRIER, TALOS and TARTAR.

A distinguishing feature of the Laboratory is the self-dependence of the professional staff members, who work in an atmosphere of free inquiry and are unhampered by the usual administrative details. Problems are attacked by teams, each of which maintains a fine balance between research and engineering. The team approach allows each member to acquire broad knowledge, find his creativity heightened.

The location of the Laboratories in the Washington D.C.-Baltimore periphery places staff members near fine housing in all price ranges, recreational and cultural facilities. Moving expenses paid in full. Liberal educational benefits for study at a number of excellent universities nearby.

OPENINGS EXIST IN:

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Applied Physics Laboratory

8607 Georgia Avenue, Silver Spring, Md.

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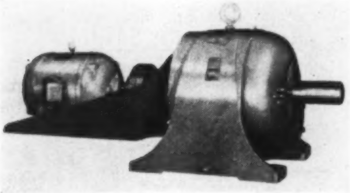
Heating Element

A new electrical resistance heating element has been developed by the Arcos Corp., 1500 S. 50th St., Philadelphia 43, Pa. The element is designed to make preheating or stress relieving pipe welds easier, less expensive and more precise, and also to require less time and labor.

Basic feature of the technique or element, known as Heat-O-Coil, is a length of small diameter resistance wire. The full length of the wire, except for several inches on each end, is strung with ceramic ball and socket beads. Each end of the coil is formed into a small ring. After wrapping the coil around the welded section of the pipe for stress relieving, the two ends are connected to the terminals on a welding machine.

Thermocouples are inserted under the coil and connected to an indicating pyrometer. After all necessary connections have been made, the section being treated is wrapped with an asbestos covering. When the hookup is completed, the welding generator is set at the amperage rate calculated to produce the necessary heat. As soon as the desired temperature is reached, as shown by the indicating pyrometer, the welding generator is adjusted manually to hold the correct temperature.

The units are available in two standard diameters and lengths. Standard length for the 1/8 in. coil, used for large diameter pipes, is 25 ft. Standard length for the 1/16 in. coil, for small diameter pipe, is 10 ft.



Motorized Reducer

Developed by Foote Bros. Gear and Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill., a new line of motorized reducers, called Line-O-Motor, combines the advantages of integral motor-reducer units with the versatility of separately mounted motors.

The reducers are equipped with a specially designed motor support bracket—the reducer base supports both reducer and motor for easy set-up and shaft alignment. Motor mounting bracket slots are standardized to suit all NEMA motors. The unit is available in horizontal models for foot mounting or in vertical and vertical extended housing models for flange mounting.

Capacity ranges from 1 to 75 hp for any AGMA service classification. Double, triple or quadruple reductions provide a selection of ratios from 5.06:1 to 238:1.

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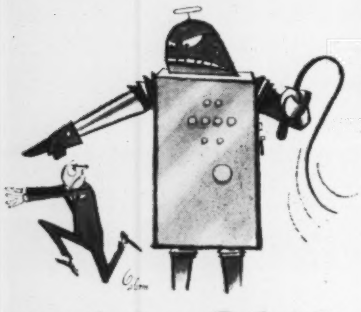
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Auto Gear Testing

Fully automatic sound testing of transmission gears in automotive and similar mass production applications is now said to be possible with automatic model 1126 gear speeders built by Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich. The entire operation, including feeding of parts from a storage hopper, clamping and speeding of the gear and either selective rejection for excess noise in any frequency band or passing through of the gear being tested is done automatically.

The firm states that electronic audio inspection of gears does away with dependence on the operator's sense of hearing and will go a long way toward keeping noisy gears out of modern transmissions.

The electronic panels can be set up to reject gears for undesirable noise levels of high, low or intermediate frequency at particular speeds within the working range of the gear. In addition the time required to speed test marginal gears is materially reduced, the company claims, because the control unit doesn't wonder whether the noise level merits rejection the way a human operator often has to do. If the noise level exceeds the prescribed amount, rejection is positive and quick.

Model 1126 speeders can be set up in line to check automotive pinions. Since the face widths of both pinions are not the same, an orienter is used to assure that workpieces after leaving the storage hopper come to the test stations in the right order. The first speeder sound tests the first gear in the cluster and the second speeder tests the second gear. The gear is rejected at either sound tester if the audio range is undesirable.

Gate Valves

A new line of Kennedy standard bronze gate valves featuring the new cylindrical design is now in production at the Kennedy Valve Mfg. Co., Elmira, N. Y. The new cylindrical body construction assures greater body strength and longer leakproof valve life.

These 125-lb bronze gate valves for steam, water, oil or gas, are available in screwed, solder joint and brazing socket ends. Sizes are from 1/4 to 3 in.

The company claims that their special accelerated-wear tests conducted with these valves prove that the cylindrical construction results in more than 10 times longer leakproof operating life than oval body valves.

Other features of this new design include Kennedy's pistol-grip handwheel combining a firm, easy three-way grip; a new improved impregnated plastic packing material selected because it maintains resiliency and resists leakage longer; heavy pipe-end hexes for maximum strength; extra weight for more durability.

Complete information may be obtained by writing Kennedy Valve Mfg. Co., E. Water St., Elmira, N. Y.

PREFERRED
Limits and Fits
for
Cylindrical Parts

Developed for use wherever it might serve to improve and simplify products, practices, and facilities, this American Standard:

lists and defines the terms applying to fits between plain (non-threaded) cylindrical parts,

presents in tabular form the preferred basic sizes of mating parts, the preferred tolerances and allowances, and a series of standard tolerances so arranged that for any one grade they represent approximately similar production difficulties throughout the range of sizes,

recommends five types: Running and Sliding Fits, Locational Clearance Fits, Transition Fits, Locational Interference Fits, and Force or Shrink Fits,

gives the standard types and classes of fits on a unilateral hole basis so that the fit produced by mating parts in any one class will produce approximately similar performance throughout the range of sizes,

prescribes the fit for any given size or type of fit; also the standard limits for the mating parts which will produce the fit,

contains an appendix giving the limits of size for holes and shafts for additional classes and grades of fits which special conditions may require.

Diameters up to 200 in. are covered with sizes in accordance with the British, Canadian, and American agreements (to 20 in.) shown in bold face type.

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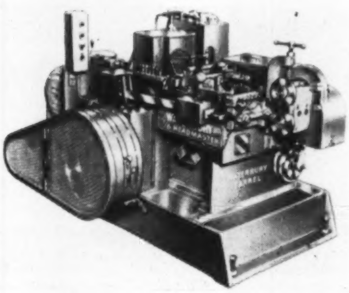

Double Stroke Header

A new solid die, double stroke cold heading machine developed by Waterbury Farrel Foundry and Machine Co., Waterbury, Conn. has production rates ranging from 300 to 450 screw or rivet blanks per minute.

Named the "Headmaster," the machine will head rivets up to $^{1}/_{8} \times {}^{3}/_{4}$, machine screws up to no. $6 \times {}^{3}/_{4}$ and sheet metal screws up to no. $8 \times {}^{3}/_{4}$. It can be equipped with either standard or Phillips type tooling.

Claimed to be the world's fastest solid die, double stroke header, the unit combines features from several different types of Waterbury Farrel headers. The features of the new machine include horizontal shifting punches, toggle actuated gate mounted on rods, friction roll feed, individually adjustable punch holders, cam operated shifter and cut-off, magnetic brake, sturdy cut-off and transfer lever, all shafts mounted in roller bearings, centralized lubrication system and variable speed drive.

The toggle actuated gate mechanism provides two blows, one long stroke and one short stroke, for each flywheel revolution. The gate advances rapidly and then decelerates on contact with the blank, producing a squeezing action rather than an abrupt blow.

Vibration Shakers

Calidyne Co., Winchester, Mass., is now producing its Model 177 shaker, one of a new series of "wide-band" shakers specifically designed for higher frequency operation and lower input requirements.

Secondary structural resonances have been so minimized that the vibrating armature behaves as a simple rigid body over an extended frequency range. The first resonance of the new model is at approximately 3000 cycles per second.

The firm says other important features of the new shaker include a force rating of 5000 lb vector, sine input and 3450 lb rms, collinear table motion, table size of 12 in. sq, 412 lb load for 10 g vector and 162 lb load for 20 g vector. It has a maximum stroke of ± .5 in. with a recommended stroke of ± .25 in. for continuous duty. The shaker weighs approximately 9500 lb. Field supply requirements are 7.5 kilowatt at 250 volts, d c. When used with electronic amplifiers, a separate rotary m-g set is supplied.

FASTENER PROBLEM

The safe way to fasten a pipeline pig

Williamson's pigs are pushed through underground pipelines by product flow, scraping scale, wax or dirt as they go. Shock and vibration are terrific as the pigs inch tons of wax and dirt at a mile an hour pace through 24" lines over the Rockies, or rocket through undersea or cross country transmission pipes at 20 or more miles per hour, bumping over welding beads every forty feet. The loss of a drive cup could mean a stalled pig and thousands of dollars in recovery costs and shutdowns. Loss of a brush or fastener could mean a mangled pump. Williamson had to have the most dependable fastener possible.

Self-locking ELASTIC STOP® nuts are used to secure rubber driving cups between steel flanges (a ticklish problem because the nuts can't be wrenched down against a firm shoulder). And they are used to anchor leaf springs to rocker seats (where an oscillating motion and continuous vibration are involved). Although Williamson pigs may stay in the line for as long as two weeks, travelling hundreds of miles . . . or complete a fifteen mile run in minutes . . . they have never had even one failure of self-locking, vibration-proof Elastic Stop nuts.

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Electronic Air Cleaner

A new electronic air cleaner, designated HEV, has been introduced by Trion, Inc., McKees Rocks, Pa.

The company claims the new unit will provide ventilation air that is twice as clean as that supplied by standard electronic air cleaners or seventeen times cleaner than air which passes through mechanical filters. It is intended for use in commercial buildings, industrial plants, laboratories and specialized applications.

One of the most important features of the new air cleaner is closer coordination with the air velocity and space requirements of air conditioning coils, the firm states. Air cleaners are placed in the return air duct upstream of the cooling and heating coils.

1200-Degree Locknut

A new line of Flexloc self-locking locknuts for use at elevated temperatures up to 1200 degrees Fahrenheit has been introduced by Standard Pressed Steel Co., Jenkintown, Pa.

The 1200-degree nuts, designated 119FW by SPS and intended primarily for aircraft use, have the high temperature and corrosion resistance necessary to maintain tensile strength and resist galling and seizing after sustained exposure to high temperatures. The one-piece, all metal locknuts, which have a 12-point external wrenching design, can be used in jet engine manifolds, afterburners and similar hotspot applications.

A prevailing-torque type of locknut, the new Flexloc has a slotted locking collar which is squeezed in slightly during manufacture. As the nut is threaded onto a bolt, the collar segments expand. Spring tension of the segments holds the nut securely in place even under severe vibration. This design lets the Flexloc serve as either a stopnut or locknut and permits repeated re-use of the fastener.

New 1200-degree Flexloc 119FW locknuts come in standard sizes from No. 10 through 1/2 in. in diameter. Nuts are made of AMS 5735 stainless steel and are silver plated.

Burner System

A new primary control designed to program and safeguard the entire operating sequence of fully-automatic rotary register oil and gas burners has been introduced by Electronics Corp. of America, Dept. CN-3, 718 Beacon St., Boston 15, Mass.

Designated Fireye System FP-2, Model 1012, it uses two flame-sensitive scanners. One scanner monitors the pilot flame and supervises the light-off sequence, while the other safeguards the main flame. The programming sequence offered in the system was especially developed for rotary register burners. To insure adequate air flow through the furnace for purging, the air dampers or louvers are driven toward the open position for 15 seconds and then back to the light-off position prior to each light-off.

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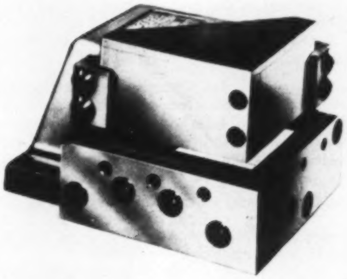
Hydraulic Fluid

An economical new "snuffer" type hydraulic fluid whose fire-resistant qualities prevent it from burning on contact with flames, heated metal surfaces or molten metal, has been introduced by the Shell Oil Co., 50 W. 50th St., New York 22, N. Y., under the trade name Irus Fluid 902.

A special formulation of water, petroleum hydraulic oil and emulsifying agents, the fluid is said to be particularly suitable for use in industries where hydraulic leaks or line ruptures would be immediate fire or explosion hazards.

The fluid eliminates the possibility of combustion by releasing its water content as a protective steam blanket to quench fire. This action reduces local temperatures and displaces oxygen from the immediate area; in most cases, the remainder of the hydraulic fluid will not support its own combustion, the company says. A further advantage is that the oil will continue hydraulic action should the water be dissipated for any reason.

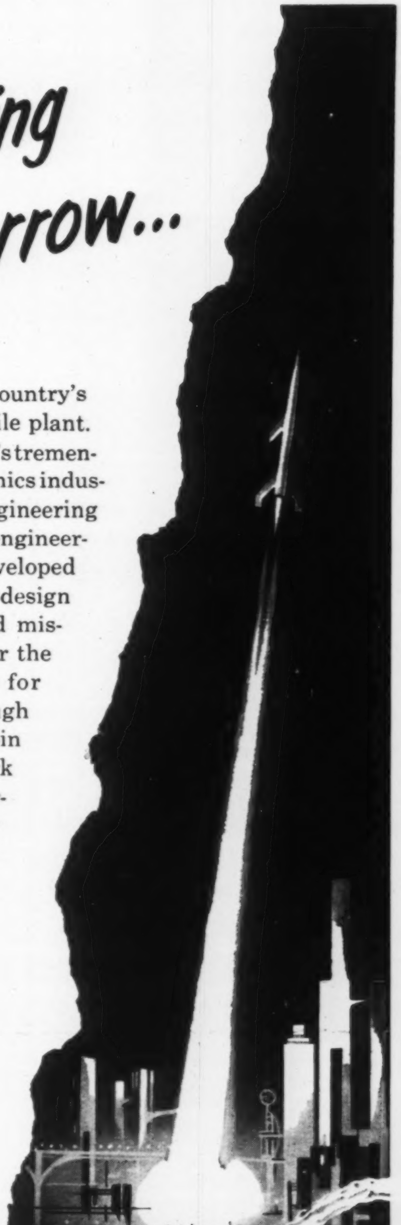


Notching Units

Announcement has been made of a new line of Uninotch corner vee and edge notching units by Punch Products Corp., 3800 Highland Ave., Niagara Falls, N. Y.

These new individual units are designed and constructed for quick, easy changing of dulled punch and die steels with new or sharpened punch and die steels. The firm says this exclusive, interchangeable advantage of cutting steels is so simple that the operation is performed even during a production run in a minimum amount of press downtime without removing the unit from setup.

The units are available in Series A and Series B with the same shut heights and die heights as the firm's Series A and Series B hole-punching units permitting combination piercing and notching operations at the same stroke of the press. Series A hole-punching and notching units have $8^{3}/_{8}$ in. shut height and $3^{1}/_{2}$ in. die height with an operating capacity up to $^{1}/_{4}$ in. metal thickness. Series B hole-punching and notching units have $5^{1}/_{2}$ in. shut height and $2^{19}/_{32}$ in. die height with an operating capacity up to $^{1}/_{8}$ in. metal thickness.



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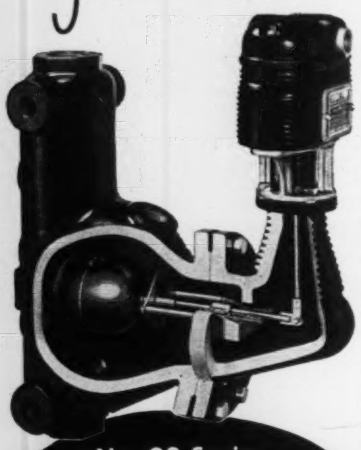
McDonnell goes High Pressure



No. 92 Series
Pump Control, Cut-off
and Alarm Switch
For pressures to 250 psi.

- Repulsion magnetic switching—for positive opening *and* closing.
- Unprecedented heat dissipation—okayed for 75° C. (167° F.) wiring at terminals.
- Extra generous clearances in float chamber.
- Operating levels unaffected by pressure changes.
- McDonnell quality throughout.
- Four models—with or without integral water column.

Use this new 92 Series for controlling boiler feed pump, or electric valves; for low water cut-off or alarm; for tank level control, etc. For lower pressures — to 150 psi. — use companion 91 Series. New catalog has full engineering data.

Write for Bulletin L-123

McDONNELL & MILLER, Inc.
3510 N. Spaulding Ave. • Chicago 18, Ill.

Doing One Thing Well

McDONNELL
Boiler Water Level Control

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Combustion Tube Furnace

A new 4-kw electric resistance element furnace Model CF-4SA accommodating one combustion tube up to 5 in. OD with maximum furnace temperature of 2750 F is offered by Laboratory Equipment Div. Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill.

In addition to its use as a standard tube furnace, the unit can be modified for use as a high temperature pot furnace or a constant temperature source for optical calibrations, the company states. Heat is supplied by eight silicon-carbide heating elements having an effective heating length of 8 in.

The large size tube allows use of furnace for production runs of small parts and is available with water jacketed Inconel tube assembly for heat treating applications up to 2150 F requiring protective atmospheres.

Power Supply

A versatile new power supply, designed for oscillograph operation but usable in many other applications, is now available from Consolidated Electrodynamics Corp.

Known as Type 3-131, it is designed to provide 23.5 to 28.5 v d c at 16 amp maximum for operation of d-c oscillographs or other equipment from an a-c line. Its power input requirements are 115 v ±10 v, at 50, 60, or 400 cps, and 4.2 amp at full load.

The 3-131 will operate over a temperature range of 0 to 150 F and take peak surges up to 50 amp for 0.2 sec without suffering damage. The unit is 17 in. wide, 12 in. high, 11 in. deep, and weighs 74 lb. It will accommodate a Cannon plug or battery lugs at its output terminals.

Further information on the Type 3-131 Power Supply is in Bulletin CEC 1570. It may be obtained from Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Oil Burner Motor

A new lightweight motor for oil burners is announced by Ohio Electric Mfg. Co., 5400 Dunham Rd., Maples Heights, Cleveland, Ohio. Rated at $^1/_4$ hp, the new unit is specifically designed for heavy duty service in oil burners used in industrial plants, institutions and apartment houses.

Underwriters Approved and built to NEMA specifications for oil burner motors with No. 56 frame, the new units are designated as $^1/_4$ hp Series 991 motors. Currently in production, they are available either for 115 or 230 volts 50-cycle (1450 rpm) or 60-cycle (1725 rpm) operation.

Breakdown torque is 29 oz/ft and locked-rotor torque 17 oz/ft. The motor is completely enclosed and is based on three-piece colnstruction design. End-bells are die-cast aluminum alloy, each with 12 strengthening ribs to provide maximum rigidity and to assure close machining tolerances. The stator ring is fabricated from a single piece of heavy 12-gage steel.

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BUSINESS NOTES
LATEST CATALOGS

Gas-Oil Burners

A new line of combination gas-oil burners for industrial applications has just been announced by Iron Fireman Mfg. Co., Cleveland 11, Ohio.

Each model of the new line has an integral air register, which eliminates the need for a checker floor and reduces installation time a great deal. The burner section and the air register are shipped as separate units. They may quickly and easily be bolted together on the job.

The oil burner is the latest model rotary cup burner, designed to fire with No. 6 or lighter oil. Oil burner ratings run from 9 to 125 gph. The ring-type gas burner has multiple tubular stainless steel jets threaded into the heat-resistant cast iron manifold ring. It may be used with either natural or manufactured gas. Capacities range from 1,650,000 Btu input per hour to 18,750,000 Btu input.

Welding Fasteners

Availability of welding fasteners in a wide variety of sizes and types to meet customers' specifications has been announced by Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y. The fasteners include welding screws, spade and bent spade screws, collar studs and nuts and designs to meet special applications.

Russel, Burdsall & Ward's engineering staff is available to assist in design and application of welding fasteners for special requirements. Recommendations and quotations can be obtained by writing to the company.

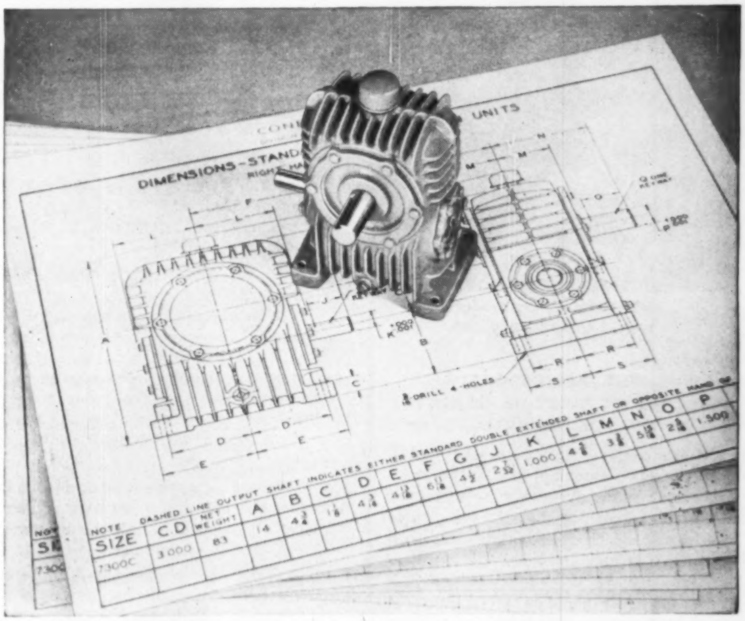
Algebraic Computer

Solution of linear algebraic equations and of problems in linear programming by an analog computer is said to have been made possible through a new computer developed by the Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America, 215 E. 91st St., New York 28, N. Y.

The firm says the new computer can obtain solutions to as many as fifteen simultaneous linear algebraic equations, and can solve problems in linear programming involving up to fifteen unknowns, evaluate determinants or any of their minors, or form the product of two or more matrices.

Programming is performed by setting input potentiometers, with no rearrangement of equations being required. Solutions are presented on a digital voltmeter and on a printer, and are accurate to the equivalence of three to four figures. Linear simultaneous equations may be solved to as many decimal places as may be desired by a simple iterative technique.

A special version of the standard Algebraic Computer can accept the output from a mass spectrograph and provide direct, instantaneous read-out of chemical component distributions.



DIMENSIONS ONLY TELL HALF THE STORY...

. . . about worm gear speed reducers. You've got to compare size with load capacity for the whole picture. Inside a Cone-Drive speed reducer you'll find the double-enveloping worm gear design that makes it the most efficient right-angle speed reducer available.

Take the standard 3" center distance unit above for example. Here are its Class I Service Ratings with a 5:1 reduction:

Worm RPM	100	200	300	580	720	870	1150	1750
Mech. HP	1.24	2.21	3.08	4.89	5.61	6.34	7.41	9.04
Thermal HP	1.24	2.21	3.08	4.20	4.62	5.10	6.00	7.80
Output Torque (inch-lbs.)	3340	3010	2830	2405	2250	2150	1940	1575

That's a lot of capacity for a unit that occupies less floor space than this magazine page. But it's typical of Cone-Drive speed reducers and gearsets. Complete details on this model in Bulletin 600-C. Other units to 800 HP and ratios to 4900:1.

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
Division, Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

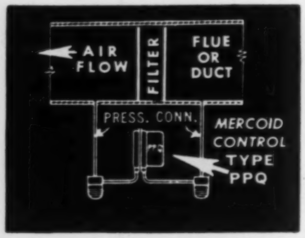
EXTREMELY
"Sensitive"
DIFFERENTIAL PRESSURE
Control
BY
MERCOID®

Has Hermetically Sealed Magnetic Mercury Switch

FOR AIR OR GAS (INCHES OR FRACTION OF INCHES OF WATER)

For low pressure or vacuum—to "make" or "break" electrical circuits on small changes in the difference between two pressures. Examples: to indicate a change in resistance through a filter (see illustration); to indicate a change in differential due to a change in air flow conditions; to indicate interruption of air flow.

This control incorporates two pressure chambers separated by a sensitive diaphragm. Each chamber is connected to a separate pressure source and the control is set to operate as the relationship of the two pressures change.



OPERATING RANGES—6" vacuum to 6" pressure (sensitivity .03") and 30" vacuum to 30" pressure (sensitivity .1" to .2").

CIRCUIT ARRANGEMENTS—several models available to accomplish the following operations:

SPST—USING ONE MAGNETIC SWITCH—open or close switch contact either on an increase or decrease at pressure difference.

SPST—USING TWO MAGNETIC SWITCHES FOR TWO STAGE OPERATION. Open/close both switch contacts on an increase in pressure difference.

Open one contact on increasing pressure difference and one on decreasing pressure difference.

Close one contact on increasing pressure difference and one on decreasing pressure difference.

CASE STYLES—three types to meet following conditions: Indoor (general purpose), Outdoor (weather resistant), and Hazardous locations (explosion-proof).

WRITE FOR BULLETIN No. 14N

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Drafting Table

Mayline Co., 619 N. Commerce St., Sheboygan, Wis., has added to its line of drafting room furniture equipment a new drafting table featuring instant table height and top tilt adjustments.

The table has an all metal base and the top is of solid basswood with metal edges. Height and tilt adjustments are made silently and quickly. A foot lever releases the brake to permit instant up or down movement and a hand lever provides the same quick action for the tilting of the table top to the angle desired.

A standard piece of equipment is the sliding reference top attached to the back side of the table. This top when fully extended projects beyond the edge of the table.

The table can be purchased in several combinations. It can be had as a table only with the reference top, or as a table with an attached book shelf which is $9\frac{1}{4}$ in. deep × $11\frac{3}{4}$ in. high, with the length depending upon the table to which applied. Also, there is available a combination of auxiliary drawer units and the book shelf.

BUSINESS NOTES

Machinery Distributor

Norton Co., has announced the appointment of Rudel Machinery Co., Inc. of 100 East 42nd St., New York, N. Y., as distributor for Norton precision grinding and lapping machinery in Eastern New York, Northern New Jersey, Connecticut and Western Massachusetts.

The appointment of Rudel will supplement Norton's own direct sales activities which have been carried on in those areas from the Teterboro, N. J. sales office.

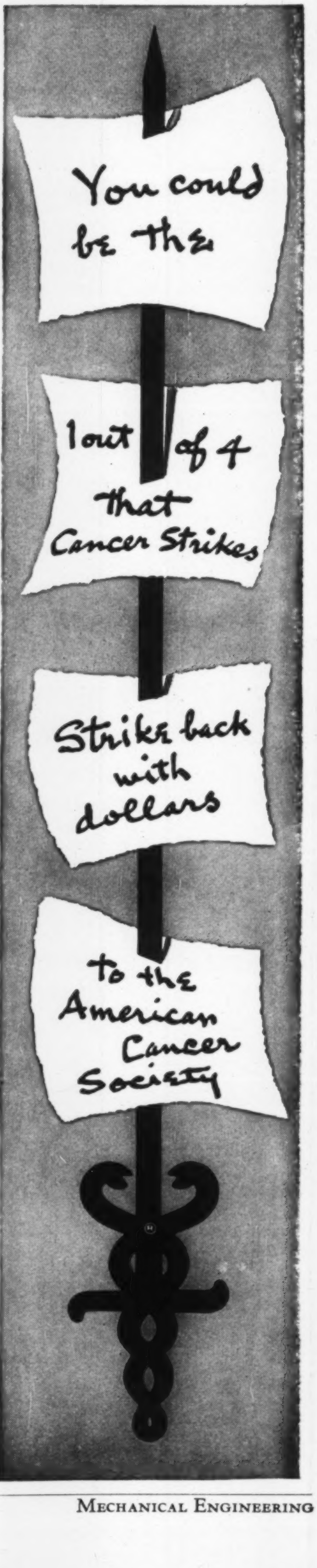
Relocates Offices

Copperweld Steel Co., Steel Div., announces the relocation of offices. The New York district sales office of the Steel Div. and the Copperweld Steel International Co., have moved from 117 Liberty St., to 225 Broadway, New York 7, N. Y.

New Engineering Offices

Harvey Aluminum, producer of wrought aluminum mill products, has opened new engineering offices at 1430 Peachtree St., N. W., Atlanta, Ga., and 505 Park Ave., Detroit, Mich.

Harvey's general offices and mill are in Torrance, California. Aluminum products fabricated by the company include rod and bar, extrusions, press forgings, special shapes, hollow sections, structurals, forging stock, pipe, tube, impact extrusions, aluminum screw machine products, and similar items in titanium and steel.



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1 out of 4 that Cancer Strikes
Strike back with dollars
to the American Cancer Society

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Lumber Drying Unit

Orr and Sembower, Inc., Reading, Pa., manufacturer of packaged automatic boilers, has entered into an agreement with Lumber Dryalators, Inc., Boston, Mass. to manufacture and sell a self-contained lumber drying unit called the Drayalator on an exclusive world-wide basis.

According to the company, the Dryalator will dry lumber faster and at less cost than conventional kiln drying units. Orr and Sembower will produce the Dryalator in its existing Reading plant facilities.

Purchases Company

Barry Controls Inc., Watertown, Mass., has arranged to purchase all physical assets of the United States Sheet Metal Products Co., Burbank, Calif. The acquisition was made to establish a west coast division for design and production of shock and vibration mountings for aircraft and missiles.

LATEST CATALOGS

Wound Rotor Motor

Construction features of wound rotor motors for a variety of applications are described in a new bulletin, No. 51B8195A, released by Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

The motors are designed for use wherever high starting torque with low starting current is needed, power supply is limited, intermediate speeds are required, smooth acceleration is desired, or where high inertia loads must be accelerated. The motors are available in open-type models, both drip and splash-proof designs; in totally-enclosed, fan-cooled and totally-enclosed, non-ventilated machines, NEMA 505 frame and smaller, and in totally-enclosed, fan-cooled design with tube-type, air-to-air heat exchangers in frames larger than NEMA 505.

Fluid Drive Bulletin

A new two-page $8^1/_2 \times 11$ illustrated two-color bulletin, No. 9719, describing the new Size 126 Type T Gyrol fluid drive for general industrial application, is now available from American Blower Corp., Detroit 32, Mich.

The new bulletin discusses construction features of the new design and outlines its advantages in typical industrial installations. Photographs show the basic unit for use with engine drives and the modified arrangement for electric motor driven applications. Also included are installation type drawings giving basic dimensions and tolerances. Rating charts give the horsepower ranges of the new unit for various engine and electric motor drive speeds.

Extruded Products

Design engineers will be interested in a new six-page folder covering extruded products, recently published by the Tubular Products Div. of The Babcock & Wilcox Co., Beaver Falls, Pa. The folder, identified as TB-413, describes the facilities for production of tubular and solid shapes, and by means of diagrams explains the Ugine-Sejournet hot extrusion process as used by the division. Included in the folder are a list of the ferrous and nonferrous alloys which have been successfully extruded into tubing, solids and shapes. Size ranges, dimensional tolerances and commercial advantages are discussed to help engineers visualize the advantages of extruded products to their own design and production problems.

Boiler Bulletin

A new four-page bulletin, "Meet the Titusville Boiler Family", is offered by the Titusville Iron Works Div. of Struthers Wells Corp. Included is a wide range of Titusville power and heating boilers, providing from 97 to more than 8000 sq ft of heating surface.

Copies may be obtained from Struthers Wells Corp., Titusville Iron Works Div., Titusville, Pa.

Pressure Piping

Installation of Transite pressure pipe for overhead industrial water and process lines is described in a 48-page guide issued by Johns-Manville, 22 E. 40th St., New York 16, N. Y.

The guide has more than 50 illustrations. Text is divided into 15 sections and covers such items as hanging and supporting the pipe, bracing for thrusts, the poured flange coupling and the Roto-Split flange coupling. Suppliers of fittings, accessories and couplings are also listed. The guide also includes diagrams of typical systems for overhead lines.

Recorders for Speed

Information about Speedomax G recorders for precise measurement of rotational and linear speeds, and about the tachometer generators used with them, is available in an illustrated four-page Data Sheet published by Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

The sheet lists the features and specifications of both round and strip-chart recorders, and tabulates the characteristics and speed ranges of both standard and explosion resistant tachometers. The Data Sheet is designated as ND46-27(1).

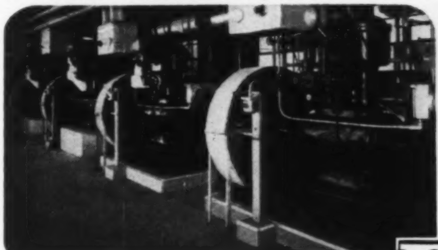
TRADE FRICK MARK® Refrigeration

Serves Velsicol Chemical Corp. 3 Ways

At the Memphis plant of this important manufacturer of insecticides, Frick equipment performs these vital functions:

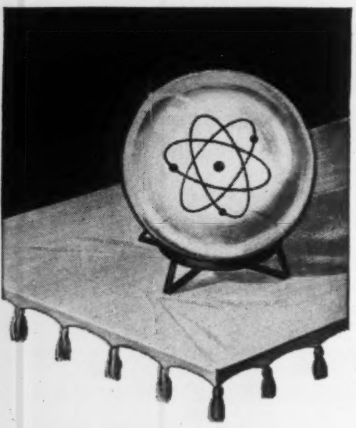
1. condenses chlorine gas to liquid form
2. cools water for chilling caustic
3. chills alcohols to 40 degrees below zero in an organic process.

Whether you need a cooling system for air conditioning, food service, ice making, quick freezing, chemical processes or any other commercial or industrial purpose, you'll find Frick ENGINEERED refrigeration the ultimate answer. Let us serve you as we now serve the biggest concerns in the world.



Four of seven Frick compressors at Velsicol's Memphis plant.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK Co.
WAYNESBORO, PENNA. U.S.A.



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Data Handling

Newly developed systems for data handling and a new series of analog computers are described in catalog C-703 issued by Berkeley Div., Beckman Instruments, Inc., Dept. 2250, 2200 Wright Ave., Richmond 3, Calif.

Engineered systems described include those for data reduction, data handling, data logging, industrial measuring and recording and industrial process control. Three new analog computers, plus four components for control systems, are outlined in the new catalog. Components include amplifiers, electronic multipliers, and function generators. The catalog also describes newly developed frequency meters, decimal counting units, events-per-unit-time meters, time interval meters, nuclear scalers, and nuclear sample changers.

Turbine Generators

A 35-page bulletin on turbine generators covering the 1500 to 15000 KW range has been released by Worthington Corp., Steam Turbine Div., Harrison, N. J.

Contents include complete information on types and applications, turbine and generator construction, testing and lubrication, sole plates, design features, and lagging. A two-page fold-out illustrates a cutaway view of a typical multistage condensing turbine, and another shows an alternating current generator. Also included are various illustrations of industrial and municipal turbine generator installations. The bulletin is designated No. 1960C-P.

Heat Exchanger Bulletin

Niagara Blower Co. Bulletin 132, Sectional Aero Heat Exchanger, illustrates and explains the functions of new equipment to provide cooling of liquids in industrial plants independent of a large supply of cooling water and with additional savings of installation and operating expenses.

Copies may be obtained from Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.

Plastics Bulletin

A new issue of its by-monthly external house organ, the "Plastics Weldor and Fabricator" has just been released by the American Agile Corp.

The issue highlights an illustrated article entitled "New Horizons in Plastic: Containers," which describes various types of containers of plastic, their advantages and applications. Of particular interest is a chart which covers the relative chemical resistance of several container materials. Another article illustrates and describes the company's newly introduced polyethylene pillows which are used to retard evaporation in open tanks and vessels as much as 70%.

Copies of the free literature may be obtained from the American Agile Corp., P. O. Box 168, Bedford, Ohio.

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ME-8

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Synchronous Motors

Construction features of large end-shield bearing synchronous motors are described in new literature released by Allis-Chalmers Mfg. Co., 949 S. 70th Street, Milwaukee, Wis.

The firm says the motors meet a demand for a high degree of protection, combined with maximum accessibility for a variety of direct-connected or geared applications to drives for centrifugal blowers, compressors and fans, centrifugal pumps, coal pulverizers, grinding mills, wood chippers, Jordan pulp refiners, banbury mixers and crackers in rubber mills. The bulletin is designed 05B8305

Vinyl Valves

An illustrated, six-page circular, describing what is claimed to be the first all-molded corrosion-resistant PVC valve ever designed by a valve manufacturer, has been published by the Lunkenheimer Co., Cincinnati 14, Ohio.

Detailed information, including advantages, installation data and dimensions of the valves and fittings is contained in the circular.

Centrifugal Pumps

Dean Brothers Pumps, Inc., 323 W. 10th St., Indianapolis, Ind., has published a bulletin illustrating and describing its type GS standard centrifugal pumps for general and chemical service.

The bulletin, designated No. 190, gives design specifications, pump shaft dimensions, sectional and cutaway views of various components. The pumps are rated for capacity up to 600 gpm, total dynamic head up to 275 ft, for liquids from −40 to +350 F.

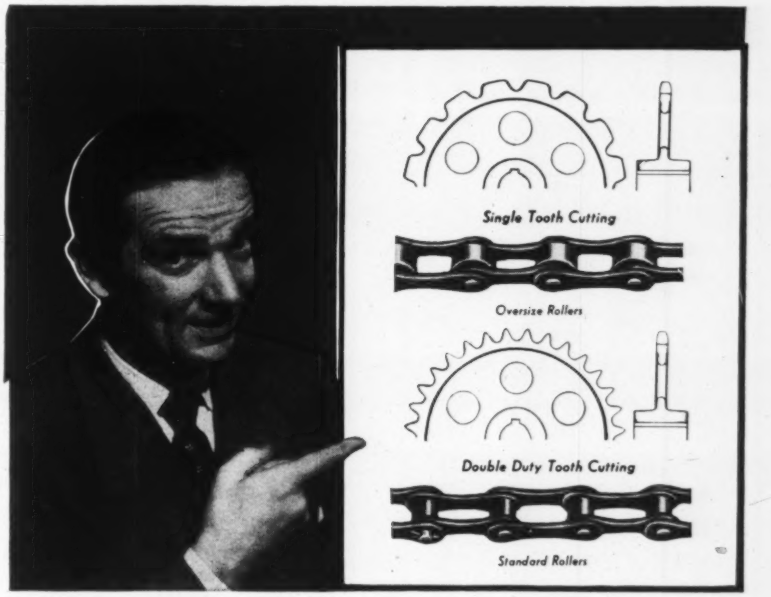
Water Well Systems

Layne & Bowler, Inc., Memphis, Tenn., has issued bulletin No. 100 on water well systems and such subjects as oil and water lubricated vertical turbine pumps, special water well drilling, service work, shutter screens, irrigation wells and pumps, water and well treatment for rehabilitating water sources and other phases of water development for industry and municipalities.

Beryllium Copper

A four-page data sheet, containing numerous tables and graphs, has been issued by the American Silver Co., 36-07 Prince Street, Flushing 54, N. Y., on beryllium copper. Designated Technical Data Sheet No. A-300, it features a section detailing the specific methods for heat-treating this metal.

The data sheet gives the engineering specifications on several of the more generally employed beryllium-copper alloys, including complete physical properties and the effect of these properties of heat treatment. Temper information on high-strength strip as well as typical age-hardening curves are also included. The beryllium copper described is rolled to thicknesses down to 0.0005 in., to tolerances of ± 0.0001 in.



Which Sprocket will live longer?

Here is double pitch chain applied on both a single and double duty tooth form sprocket. The single duty sprocket is necessary for use with double pitch chains using oversize rollers. The double duty sprocket used with double pitch chain having standard diameter rollers, has another 'life' by simply moving the chain up one tooth after it is worn in its first position. Double duty cutting in many cases, doubles the life expectancy of a sprocket.

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LATEST CATALOGS

Injection Molding Machines

An eight-page bulletin describing the operating features of vertical injection molding machines which are available in 1, 2, 6, 16 and 24-ounce capacities is available from Watson-Stillman Press Div., Farrel-Birmingham Co., Inc., 109 Aldene Rd., Roselle, N. J.

The bulletin, No. 627-B, also describes the advantages of the vertical method of injection molding. Information on machine specifications and physical dimensions is included.

Control Valves

Valvair Corp., 454 Morgan Ave., Akron, Ohio, announces a six-page bulletin on the company's line of Speed King pilot operated control valves.

Printed in three colors, the bulletin describes the operation, uses, optional features of single and double solenoid valves. It includes tables on types of service, pressure ranges, condensed specifications and dimensions.

Controlled Atmosphere Furnaces

A four-page two-color bulletin which describes the firm's line of hydryzing furnaces for hardening high carbon and high speed tool steels without scale, decarb or carburization has been issued by the Furnace Div., Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill.

Cross-section diagrams, specifications and performance data on preheat and high speed furnaces are listed. Included is a discussion on the operation and features of the company's Hyen hydrolyzing generator, said to be an inexpensive, fully automatic processs for producing atmosphere. The bulletin is designated 97-HS.

DEFINITIONS OF OCCUPATIONAL SPECIALTIES IN ENGINEERING

A good book to consult for authorized definitions of approximately 500 occupational specialties in engineering.

Prepared by the ASME with the assistance of representatives of pertinent national Engineering Societies.

Published, 1951 $2.50
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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York 18

KEEP INFORMED
NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Portable Lifts

A new catalog sheet, illustrating and describing three models of its line of portable lifts, has been released by Oster Mfg. Co., Box 4326, Cleveland 32, Ohio.

Its Model L1112-P, a 112-in. power operated portable lift, Model L2056-P, a 56-in. portable lift either power or hand operated, and its Model L542, a 42-in. hand operated portable lift, are detailed. In addition to product photos, the literature also contains operating shots showing lifts handling crated goods, barrels, and machine components. Illustrations also show the units used for handling, in lieu of a truck dock, and as a work positioner.

Remote Control System

A four-page brochure covering, plug-in package remote control system for two-position discreet operation of starters, pumps, valves, loaders, gates and operators is available from Sparton Control Systems Div., Sparks-Withington Co., Jackson, Mich.

High Pressure Meters

A new eight-page bulletin, No. 571, on the complete line of high pressure meters, has been published by Granberg Corp., 1308 67th St., Oakland, Calif. Included in the brochure is a complete description of three types of high pressure meters: positive displacement; double-case; and the latest model, the Granco Duo-Rotor meter. Capacities of these high pressure meters go up as high as 30,000 gpm.

The booklet contains metering principles, dimensions and specifications, engineering data and pressure-drop charts for all three models. Also included are high pressure meter accessories.

All-Speed Drive

Variable speed drives with touch control is subject of new bulletin offered by Worthington Corp. The bulletin contains information about features, operating principle, design, component parts, definition of engineering terms and formulas and includes selection tables and graphic illustrations of drive dimensions. Also contained in the bulletin is complete information about allspeed modifications and accessories as well as pictorial illustrations of allspeed drive applications.

The Worthington all-speed drive is designed to offer simple maintenance with standard hand tools, a minimum of repair parts, easy operator control, low initial cost and a flexibility to meet every speed requirement. Featuring twin-V tandem belt design, compact compounded sheave design, automatic positive belt tensioning, constant-speed regulation, automatic belt tension indicator and driving pin construction, the drive is available in sizes from 1/3 through 5 hp.

For copy, write Advertising & Sales Promotion Dept., Worthington Corp., Harrison, N. J., specifying Bulletin 1600-B7 P.

Is Space an Important Factor?

Then Use This Distinguished Line of Close-Coupled Pumps

These GMC Pumps are ideal for a multitude of jobs. Smooth and efficient whether vertical, horizontal, up-side-down or any inclination. Low first cost, low power and maintenance costs. Top quality "by Aurora."

Caps. 10 to 800 G.P.M.
Heads to 250 Ft.

Type GMC AURORA® Close-Coupled Pump

AURORA Always PUMPS

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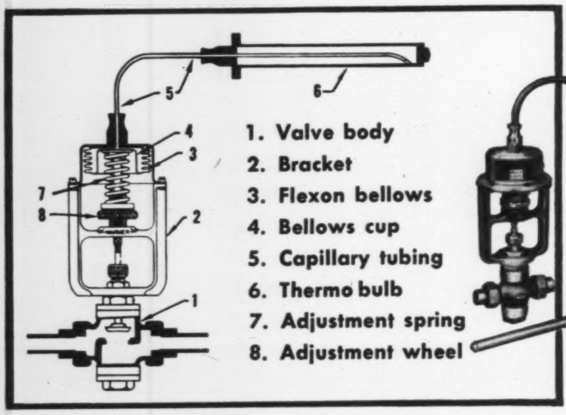
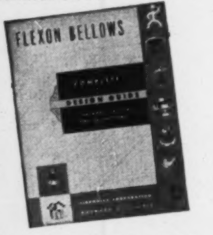
FLEXON® BELLOWS *Design Briefs*

Flexon Bellows Converts Vapor Pressure to Closing Force in Temperature Regulator



FLEXON® OFFERS THE COMPLETE BELLOWS SERVICE

Flexonics Corporation manufactures a complete range of bellows and bellows assemblies in brass, bronze or stainless steel.



The Flexon Bellows Design Guide gives valuable application and design information. Write for your copy, today.

Lawler thermostatic temperature regulators are self contained vapor-pressure-operated devices for automatically regulating the flow of liquid or steam through a valve. Manufactured by Lawler Automatic Controls Inc., Mount Vernon, New York, the type "S" illustrated is only one of the Lawler Line of thermostatic controls that rely on Flexon Bellows to translate vapor pressure into positive action of the valve disc, thereby regulating flow.

If your product must be temperature sensitive—or pressure sensitive—specify Flexon Bellows developed by cost-conscious Flexonics engineers who know how to combine performance with economy.

Let us examine an outline of your requirements—we may be able to show you the way to lower costs.

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FLEXON® QUALITY
proved in service and backed by over 54 years manufacturing experience

B-35

Flexonics *Corporation*
FLEXON BELLOWS DIVISION
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Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Process Equipment

Large scale and special purpose process equipment for the chemical, textile, plastic, rubber and allied industries is described in a new brochure, No. 236, published by Dravo Corp., Neville Island, Pittsburgh 25, Pa.

Design and construction details are given for intensive mixers, liquid blenders, dissolvers, kneading machines, pressure filters, ball mills, conical blenders, horizontal blenders, quick-opening doors, pressure vessels, and other types of process equipment. Also described are facilities for manufacturing process equipment at the firm's plant.

Engineering Manual

Amplex Div. of Chrysler Corp. announces the release of an entirely new engineering manual. Listed as the "E-56 Engineering Manual," the book is thoroughly revised from previous years and contains complete details about Oilite products.

For instance, it includes data on properties of Oilite materials and it lists Brinell and Rockwell ratings for Oilite materials. Rich in illustrative material, the book contains new and more complete descriptions of the industrial applications of Oilite materials.

The 52-page manual contains a special 12-page insert which lists over 1000 standard Oilite sleeve, flange and thrust bearings, cored, solid bar and plate stock, available for shipment in any quantity.

Copies of the "E-56 Engineering Manual" are free and may be obtained by writing to "Amplex Div., Chrysler Corp., Detroit 31, Mich.," or from any of the 16 Oilite representatives located in principal cities throughout the nation.

Ring Catalog

Alco Products, Inc. has announced the availability of a 16-page bulletin on the production of seamless forged and rolled rings from Alco-made steel. The illustrated booklet details Alco's experience in steelmaking at its Latrobe, Pa. plant.

Contained in the bulletin is a handy four-page chart showing, in 8-in. divisions, weights for rings from 1 to 145 in. overall-diameter. The bulletin is available from all Alco regional sales representatives or by writing Alco Products, Inc., Box 1065, Schenectady, N. Y.

Pressure Vessel Fittings

The firm's line of elliptical manhole saddles, rings and fittings for pressure vessels is described in Bulletin 565, released by the Lenape Hydraulic Pressing and Forging Co., Dept. 30, Box 536, West Chester, Pa.

The six-page bulletin includes detailed specifications for elliptical curved and flued saddles, elliptical straight rings and standard pressed steel handhole and manhole fittings ranging in size from 4 × 6 in. to 18 × 24 in. Materials, finish, and application data for these products are also described.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Grinding Wheels

The dressing of grinding wheels by airless abrasive blasting during the state of manufacture is the subject of a bulletin published by Wheelabrator Corp., 1149 South Byrkit St., Mishawaka, Ind.

The bulletin discusses the case history of a prominent grinding wheel manufacturer who uses abrasive blasting for this work. Advantages outlined are increased dressing speed, saving of material, elimination of lacquering of recessed areas, and production of a better and more attractive finished product. The bulletin is designated No. 121-D.

Electric Motors

A revamped bulletin No. 1878, which now includes a more complete line of motors is being released by U. S. Electrical Motors Inc., Box 2058, Los Angeles 54, Calif.

Descriptions and full-color illustrations are included of open-type Uniclosed designs, totally-enclosed and explosion-proof types, Varidrives, Syncrogears, and right-angle worm gear models; also vertical motors and Verticlosed hollowshaft types.

Spectroscopic Electrodes

A detailed listing and description of its line of spectroscopic electrodes and powders is presented in a 16-page catalog available from National Carbon Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y.

Stressing the purity necessary in spectroscopically detecting quantities as small as one ten-millionth of a gram, the catalog, No. A-4004, discusses both the initial purity obtained through intensive purification processes during manufacture, and maintenance of purity made possible by special protective packaging. The major portion of the catalog deals with 37 special grade preformed electrodes. Actual size photographs and dimensioned drawings illustrate the special grade preformed electrodes.

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These Features are
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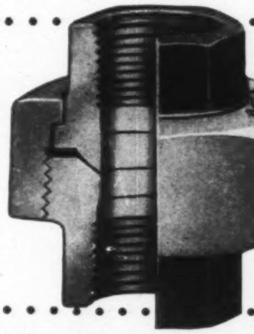

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ASTM A-105, GRADE 2
2. SPHERICAL-TO-ANGLE MATING SURFACES
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W-S Unions are available in 3000 lb. class, sizes ⅛" to 3" in screw-end and socket-welding types. Send today for your copy of Bulletin U-1.

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WITH H & R SINGLE-PASS ACME TAPS

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Available from stock in diameters from ⅜" through 2", by eighths, in standard pitches. Specials available on order. Write today for details, prices.

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Oakland 8, California 20

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Electric Brake

A technical bulletin describing features and operating characteristics of its new Series E electric brake has been released by Star-Kimble Motor Div., Miehle Printing Press and Mfg. Co., 200 Bloomfield Ave., Bloomfield, N. J.

According to the firm, the new brake incorporates unusual design features of special interest to users of magnetic disk type brakes. These are fully described and illustrated in the eight-page brochure, designated Bulletin C-11.

Hydraulic Motors

A two-color bulletin, DM 321, describes the Dudco MF-100 series vane-type hydraulic motors manufactured by the Kalamazoo Div., New York Air Brake Co., Kalamazoo, Mich.

The balanced dual-vane fluid motors are the constant displacement type. Their speed varies directly with the quantity of fluid supplied and torque varies directly with the pressure. Cut-away illustrations of the pump show how the dual vanes are hydraulically balanced. There is a selection data chart for the four motors in the series which operate at pressures up to 2000 psi and maximum continuous speeds up to 2400 rpm.

Centrifugal Pumps

A bulletin covering its line of class CRV cradle-mounted centrifugal pumps has been announced by Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y. Pumps described have capacities from 5 to 2800 gpm and pressures of 10 to 525 ft total head.

A tabulation of pump types with their rating is included, along with a cross-section view, applications, and installations. Performance tables and dimensions for the entire line are shown. Two pages describe various modifications which are available for special applications. Request Form 7223-B.

Roof Ventilators

A revised catalog, Bulletin A-112A, covering its line of roof ventilators has been published by the Hartzell Propeller Fan Co., Piqua, Ohio.

The catalog contains information on the firm's reversible roof ventilator as well as penthouse, Vertijet, Airjet and rotary roof ventilators. Sizes, specifications, performance data, and dimensional drawings are shown. The catalog is designated Bulletin A-112A.

High-Torque Motors

A bulletin featuring new 10 and 15 hp all-weather high torque, capacitor-start, capacitor-run single phase motors is available from Robbins and Meyers, Inc., Motor Div., Springfield, Ohio.

The two-color, four-page bulletin describes the new motors' features, which include protection against the weather, debris and small field animals. The motors are available in 1725 and 1140 rpm speeds.

Asbestos-Cement Sheet

An illustrated, six-page folder issued by Johns-Manville, 22 East 40th St., New York 16, N.Y., explains how asbestos-cement sheet material can serve industry and shows typical applications.

These include the use of Asbestocite for cooling tower housings, for cold storage room facings, for a weather protection on insulated outdoor tanks, and for the construction of fume hoods and ducts. The folder gives information on physical properties, sizes, thicknesses and dimensional tolerances. Also included is a section on cutting, working, and applying.

Heavy Machinery

A new 44-page booklet, entitled "This is Farrel-Birmingham," is available on request to Farrel-Birmingham Company, Inc., Ansonia, Conn.

The booklet gives a presentation of the company's ability to design and manufacture a wide variety of heavy machinery and machine tools in its four plants at Ansonia and Derby, Conn., and Buffalo and Rochester, N. Y.

See you at the Polls!

You could call this "the hi-sign of good government". . . or "taking aim on the right candidate". . . or "eyes right on better representation". Whatever you call it, it's the right idea. The idea is to vote . . . and get your friends to vote. Make *sure* the candidates elected in November are the ones who will best represent *you*. Argue, read, talk, study, listen, think, persuade, decide, and then finally—

VOTE NOV. 6

THE AMERICAN HERITAGE FOUNDATION
PUBLIC SERVICE ADVERTISING COUNCIL

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Cable Conveyor System

Information needed to order and install a cable conveyor system, including an unusual diagrammatic plan for layout and dimensional calculations, is contained in a 36-page illustrated engineering manual issued by the Tipp Mfg. Co., Tipp City, Ohio.

A separate section on the Tipp-Tronic, the new automatic safety controller that provides warning and prevents damage from abnormal load conditions of any kind on electrically driven conveyor systems, is included in the manual. Featured is a new standard trolley, redesigned for more efficient operation and easier installation and maintenance.

Pneumatic Operators

Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa., has issued a new bulletin on pneumatic spring and diaphragm operators. Bulletin B-1020-5 illustrates and describes Series B-10 and B-20 spring and diaphragm Conomotors available from the factory in complete valve assemblies.

The bulletin shows the operator in various typical combinations with a butterfly valve, adjustable port valve, burner valve, etc.

Snap-Action Thermostats

A condensed catalog listing physical, electrical and performance specifications for snap-action, locally-adjustable thermostats is offered by Fenwal Inc., Ashland, Mass.

The four-page two-color catalog describes in pictorial and tabular form the assortment of head styles, snap switches, electrical ratings, temperature ranges and modifications for the Series 20000 Thermoswitch. The catalog also presents general information about snap-action thermostats, and discusses the various installation and service factors which affect temperature control, regardless of the type of controller used. The catalog is designated MC-120B.

Carmet Booklet

A revised 32-page booklet entitled "Carmet Catalog," which gives detailed information, charts and other data on carbide applications and available tools with carbide tips, is now being distributed by Allegheny Ludlum Steel Corp. Carmet is the carbide producing facility of Allegheny Ludlum.

The catalog gives detailed data on all Carmet products including standard blanks, insert blanks, throw-away blanks, special blanks, standard tools, die sections and punches, die inserts, piercing punches and bushings. In addition to the catalog listing of Carmet products, there is a section on the selection of carbide grades which most carbide users will find interesting and helpful.

A copy of the catalog can be obtained by writing to the Advertising Dept., Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa.

Freeze-Drying Units

"Freeze-Drying Equipment for Laboratories" is the subject of a new 36-page catalog published by Arthur S. LaPine and Co., 6001 S. Knox Ave., Chicago 29, Ill.

The catalog includes descriptions of new freeze-drying units, vacuum gages and pumps, bath coolers, refrigerated centrifuges, and related laboratory and small-scale production equipment. The method of freezing and then drying under high vacuum has many unique advantages for preserving heat-sensitive substances such as pharmaceuticals, biologicals and food.

Shut-Off Valve

Aircraft Products Co., 300 Church Rd., Bridgeport, Pa., has issued a data sheet on its new Series 6100 and 6200 two-way, solenoid-operated shut-off valve for 3000 psi hydraulic service.

The two-page, two-color sheet describes and illustrates the new valve line which has a straight-through port construction with threaded connections for $^1/_4$, $^3/_8$, and $^1/_2$-in. tube sizes. Also listed are specifications and references to military specifications met by the line. Dimensions and a graph giving pressure drop versus flow rate are included.

NATIONAL AIROIL FUEL OIL - GAS BURNERS

SERVING INDUSTRY FOR 45 YEARS

- Steam Atomizing Oil Burners
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Detailed information gladly sent you upon request on your business letterhead, please.

Established 1912 — NATIONAL AIROIL BURNER — Incorporated 1917

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Analytical Engineers to work on

THE MIGHTIEST ENGINES MADE BY MAN

At this level of Rocket Engineering, the opportunities are great—because the right men are few. If you are such a man, this is where you belong:

DESIGN: Working knowledge of hydrodynamics, gas dynamics and applied thermodynamics as related to nozzles, turbines, pumps and control systems. Involves the application of systems engineering concepts in analytical integration of components into compatible propulsion systems. Broad field: evaluate new engines; solve special problems in compressible and incompressible flow, combustion, heat control; develop prediction techniques for exceptional operating conditions.

EXPERIMENTAL: Sound background in hydrodynamics and thermodynamics required, with 5 years related experience, preferably propulsion. Plan performance experiments; study efficiency of systems; relate results to basic fundamentals of present models' operation, apply findings to future engines.

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LIBERAL RELOCATION EXPENSES TO SOUTHERN CALIFORNIA

Write or contact direct: Mr. A. W. Jamieson, Rocketdyne Engineering Personnel, Dept. 596 ME, 6633 Canoga Ave., Canoga Park, Calif.

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A DIVISION OF NORTH AMERICAN AVIATION, INC.

Water Chiller Bulletin

The Trane Co., La Crosse, Wis., has announced a revised "Cold Generator" bulletin covering its line of 10 through 150 hp packaged, reciprocating water chiller units for industrial and commercial, comfort or process applications. Trane manufactures 35 complete lines of air conditioning, refrigeration, heating, ventilating and heat transfer equipment.

The revised bulletin includes new capacity tables on the company's 10, 20 and 50 hp machines, which now have an internal fin extended surface arrangement allowing for maximum refrigeration capacity with smaller over-all unit size. Also included is new data on Trane 60, 75 and 100 hp Cold Generators, which have been redesigned to use straight tube condensers with removable heads. The use of straight tubes provides for mechanical tube cleaning, and easy replacement of tubes.

Information on chiller inlet and outlet water connections, which have been increased in size to gain the advantage of lower over-all water pressure drop through the chiller is given as well as data on the two largest size packaged units, the 125 and 150 hp machines.

Further information about Trane Cold Generators, such as water flow arrangements for all types of systems, construction features, controls, selection factors, etc., can be obtained by writing to Trane, La Crosse, Wis., for Bulletin DS-352.

Dust Collection

Torit Mfg. Co., 292 Walnut St., St. Paul 2, Minn., has issued a standard envelope-size booklet titled "You Can Solve That Dusty Cost Problem" that describes the principles of unitized dust collection, its advantages and savings.

Illustrated with cartoons, cutaways and product photos, the booklet describes dust damage, general product information, uses and reductions in operational expenses. A photomicrograph of various types of industrial dust is also included.

Vibration Mounts

A design procedure for application of shock and vibration mounts to protect shipboard and vehicular equipment is outlined in a new bulletin, No. 56-02, published by Barry Controls Inc., 920 Pleasant St., Watertown 72, Mass.

The design procedure includes performance data and characteristic curves for obtaining proper system natural frequency to protect equipment. Performance data includes typical transmissibility curves for center-of-gravity and base-mounted equipment, isolation efficiency, load deflection and natural frequency curves and load ratings. Static and dynamic characteristic curves are given for all 16 load ratings from 20 to 1800 lb per isolator.

Press Brake Catalog

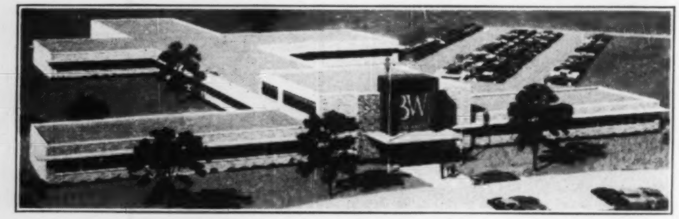
A revised catalog describing "Steelweld Press Brakes" has just been issued by The Cleveland Crane & Engineering Co., Wickliffe, Ohio.

Construction details are described and illustrated. Dimensions and specifications are given for the entire standard line of press brakes which range in bending capacity to 14 ft × $^3/_4$ in. mild steel. Catalog No. 2010-J will be sent free on request.

Remote Condensers

Kramer Trenton Co., Trenton 5, N. J., announces the publication of a new bulletin, U210D, introducing its all-season Unicon, a remote-type condenser.

The bulletin contains application information, specifications and rapid selection charts covering all sizes up to 300 tons. The new Unicons are the largest single unit air-cooled condensers in production anywhere in the world, according to company officials.


Research Center • Borg-Warner Corporation

Borg-Warner Corporation has challenging positions for professional personnel at all levels of experience in its new Research Center in attractive suburban Chicago. Unusual opportunities for future advancement are presented in the listed catagories, and liberal fringe benefits are included.

MATERIALS ENGINEERING—B.S., M.S., Ph.D.

High temperature cermets and refractory compounds; enamelling techniques; physical and process metallurgy in light-metals technology.

NUCLEONICS—B.S., M.S., Ph.D.

Control materials, fuel elements, and reactor mechanical hardware.

ELECTRONICS AND APPLIED PHYSICS—B.S., M.S., Ph.D.

Transducers; microwave generators; ultrasonics; electron and X-ray diffraction; solid-state physics.

APPLIED MECHANICS AND MECHANICAL ENGINEERING—B.S., M.S., Ph.D.

Exploratory research, design, product development, and manufacturing processes for mechanical and hydraulic equipment in automotive, nuclear, home-appliance, and transportation industries.

ECONOMIC STUDIES AND OPERATIONS RESEARCH—M.S., B.S., Ph.D.

Mathematical analysis; technical economic feasibility studies; product and program planning; operations research; computer programming and operation.

Send confidential résumés to
Technical Personnel Officer

RESEARCH CENTER
BORG-WARNER CORPORATION
DES PLAINES, ILLINOIS

Fittings Catalog

A new 28-page catalog on forged steel pipe fittings is now available from W-S Fittings Div., H. K. Porter Co., Inc. Bulletin A-3-56 contains complete dimensional, engineering and application data on the division's forged screw-end and socket-welding fittings for high pressure service. The catalog features a reorganization of data into simplified charts, permitting faster and easier location of fittings information.

The new W-S catalog presents useful data on the company's forged steel unions, reducer inserts, welding bosses and special fittings. The engineering data section contains helpful information on materials selection, pressure ratings, pipe thread and socket-welding specifications and useful hydraulic and mathematical tables.

For a copy of Bulletin A-3-56, write to Mrs. Wilma Newton, W-S Fittings Div., H. K. Porter Co., Inc., P. O. Box 95, Roselle, N. J.

Dry Processing

Dry processing equipment is the subject of an eight-page booklet being made available by Sturtevant Mill Co., 150 Clayton St., Boston 22, Mass.

The "open-door" feature of firm's equipment is described as meaning that the vital parts of any unit are accessible by one man in one minute, and that cleaning, inspection and maintenance are accomplished easily and fast. The literature also discusses the firm's "Cooperative Engineering Plan" which permits a manufacturer with a problem to take advantage of Sturtevant's 80-plus years of experience at either no cost or a charge proportional to the value received whether that value be in the form of specific recommendations or a completely engineered job.

Casting Aluminum

A new book, "Casting Kaiser Aluminum," is currently being released by the Technical Publications, Dept. A-23, Kaiser Aluminum & Chemical Corp., 919 N. Michigan Ave., Chicago 11, Ill. In this 388-page book, extensive information on all phases of aluminum casting has been carefully correlated into a single volume. Progressive foundry practices are treated with a complete analysis of aluminum casting alloys and their characteristics.

Information has been divided into the operations performed. General headings deal with casting steps and treatment of specific phases within the foundry. Main book sections present characteristics of aluminum casting alloys, general availability, furnaces for melting aluminum, chemical and physical characteristics of molten aluminum, and casting methods.

Copies may be obtained free when requested on company letterhead, or at a cost of $5 for personal libraries.

Photoelectric Encoder

Electronics Corp. of America, Cambridge, Mass., announces a new illustrated bulletin describing Type 309-13 Shaft-Position Encoder. This unit is a precision photoelectric analog to digital converter for direct reading of shaft positions to an accuracy of one part in 8192. It is used in mechanical testing, missile guidance, radar, optical tracking and other applications in which the angular position of a rotating shaft expressed as digital information is required.

The bulletin describes and illustrates the principle of operation and gives full specifications as to accuracy, readout rate, size and mounting. Also described are other ECA shaft-position encoders with nonlinear read-outs and accuracies up to one part in 65,536.

Bulletin 4605 may be obtained by writing Electronics Corp. of America, Dept. 500, 77 Broadway, Cambridge 42, Mass.

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Clutches Are Spin Strength Tested to Meet The Needs of Modern High Speed Engines

First they are put in a deep, armor-plated, concrete test pit.

Then fastened on a shaft that spins the clutch at high speed.

The clutch is spun, and highest R.P.M. recorded.

Let us help insure fully-tested clutches for YOUR products.

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Clutch Division
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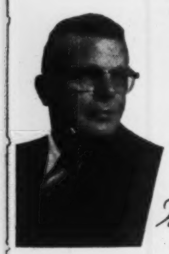
1307 Eighteenth Ave., Rockford, Ill.

CLUTCHES

Finding the
ROTTEN
APPLE
in the
BARREL



William B. Dunn

CHIEF INSPECTOR, THE CINCINNATI GEAR CO.

Several years ago we ran an ad entitled "Ears for Gears" that produced a lot of comment. The unusual title was explained in the copy, in which we told how we can individually *sound check* gears for minimum noise level. This checking is done on ultra-modern testing equipment, under specified load and R.P.M., measuring the decibel tolerances of the individual gears. Not only does this help us produce silent-running gears, but it is also one example of the extensive checking and testing to which we subject our gears, to be *sure* of maintaining our reputation for delivering only *good* gears.

This checking and testing, which is the responsibility of my department, is one of the most important functions in our plant. It's always *possible* for a "rotten apple" to slip into the barrel, but it's *essential* that it be found and removed before shipping. That's why my department can't afford to make any mistakes, or compromise in any way. Top management realizes this; they provide us with the best available equipment, and I report directly to our President (eliminating any possibility of "shop influences" in our testing standards). As a result, our customers have the assurance that when they send us an order they'll receive only the best custom gears obtainable.

THE CINCINNATI GEAR CO.
CINCINNATI 27, OHIO
"Gears—Good Gears Only"

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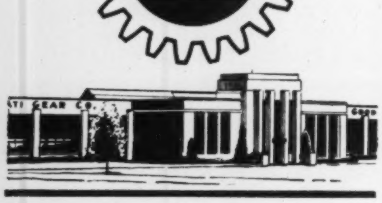

CINCINNATI GEAR CO.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Automatic Coal Scale

Operation, components and auxiliary equipment for two models of high-speed automatic coal scales are described in a two-color, 16-page bulletin, No. 0352A, offered by Richardson Scale Company, Clifton, N. J.

Designated H-39, the coal scale is available in a 200 lb model with an hourly capacity up to 20 tons, and a 500-lb model with an hourly capacity up to 40 tons. The bulletin illustrates and describes feeding, weighing, and discharge cycles of the scale. Also, such components as belt feeder, weigh hopper, housing and controls, and operating levers are discussed.

Aluminum Pipe

The long service life of aluminum pipe is described in a booklet available from Aluminum Co. of America, Room 780, Alcoa Bldg., Pittsburgh 19, Pa. Titled "Alcoa Aluminum Pipe for Oil Country Service," the booklet also tells of aluminum pipe's advantages of economy, installation, easy portability and corrosion resistance. The full picture regarding money and labor savings realized through the use of aluminum pipelines is presented in the booklet.

Copper Forgings

A 12-page illustrated booklet on aluminum, brass and copper forgings is being released by Rome Mfg. Co. Div., Revere Copper and Brass, Inc., Box 111, Rome, N. Y.

It depicts a variety of forged parts and explains and emphasizes the superiority of die-pressed forgings over those produced by other methods. Charts are included which enumerate the physical, mechanical and fabricating properties of various copper base alloys and aluminum alloys.

Refrigeration Controls

Furnas Electric Co., 1048 W. McKee St., Batavia, Ill., has published Bulletin No. 5610 presenting design features and engineering data on a new line of air conditioning and refrigeration motor controls.

The controls are rated in four sizes, 20-30-35-50 amperes, to match motor requirements. The eight-page bulletin contains voltage rating charts, outline diagrams, heater coil tables, application photos, and list prices.

Regulator Models

A revised version of '1001' Regulators, Bulletin No. 1059, has been issued by Meter and Valve Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

New features of the revised 12-page bulletin include photo-illustrated descriptions of a recently introduced 250-lb type high-pressure model of the '1001' which offers a maximum capacity of 200 psi and outlet pressure range from 5 to 60 psi, and maximum capacity tables for all models.

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SYSTEM PROGRAM
ELECTRONICS DIV.,
Milwaukee 2, Wis.

Seeks Engineers with experience in

- Vibration and Stress Analysis
- Mechanical Design
- Electronics Package Design
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Enjoy Challenging Opportunities in the most versatile Laboratories in the country. Work with the top men in the field and with the finest test, research and development facilities. We are in the process of a Major, Permanent, Expansion Program. New Plant facilities being added in suburban Milwaukee area.

To aid you in your professional advancement AC will provide financial assistance toward your Master's degree. A Graduate Program is available evenings at the University of Wisconsin, Milwaukee.

GM's Electronics Division aggressive position in the field of manufacture and GM's long-standing policy of decentralization creates individual opportunity and recognition for each Engineer hired.

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Milwaukee offers ideal family living in a progressive neighborly community in cool, southern Wisconsin where swimming, boating, big league baseball and every shopping and cultural advantage is yours for the taking.

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Bearing Folder

A two-color, eight-page folder recently published by Smith Bearing Co., gives a detailed description with diagrams and illustrations of their cam followers and cam yoke rollers. The folder gives load and life ratings, as well as specifications for the H C S (High Capacity Stud) the regular type and the new cam yoke roller bearings.

Engineering Bulletin No. 103 may be obtained by writing to Smith Bearing Co., 13 Bear Tavern Rd., West Trenton, N. J.

Furnace Bulletin

Three models of Surface allcase furnaces are described in a new two-color bulletin. The versatile allcase batch type furnaces have an operating range from 1400 to 1750 F and can be used equally well for gas carburizing, clean hardening, dry cyaniding, carbon restoration, homogeneous carburizing, clean annealing, oil quenching or marquenching. The bulletin illustrates these Surface suction radiant tube fired units and the available mechanized allcase systems. Write for bulletin SC-174 to Surface Combustion Corp., Toledo 1, Ohio.

Lubrication Service Sheet

A two-page, two-color service instruction sheet providing service information and operating instructions for build-in "One-Shot" lubricating systems is offered by Bijur Lubricating Corp., Rochelle Park, N. J.

Designated Type KI, the lubricator is a spring discharge piston pump mounted in a reservoir on the machine. These Bijur pull-type lubricators are widely used for centralized oiling of table and cross-feed ways of milling machines, grinders and similar equipment requiring closely controlled but infrequent oiling. Sections of the sheet discuss operation of the lubricators, maintenance, service, "starting a new machine," and types of oil to be used. A large photograph shows various components of the piston pump mechanism. Sixteen smaller photos show types of Bijur meter-units and four tables give specification details of hose fittings, tubing, junction and compression fittings used in Bijur lubrication systems.

For copies of this instruction sheet on KI lubricators, write to "Service," Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.

Metering Pumps

A 12-page, two-color booklet, No. 600, featuring metering and proportioning pumps as used in water conditioning has been released by Hills-McCanna Co., 2433 W. Nelson St., Chicago 18, Ill.

The booklet illustrates typical installations for the injection of inhibitors in water conditioning systems. Included are pump specifications, a table listing the chemicals commonly used in water conditioning, what they are used for, and the pump construction best suited to inject them.

Instrumentation Method

Power and process plants are now making control systems flexible, reducing parts stock, and simplifying personnel training through a new method of instrumentation. Users select from a line of standardized, multi-purpose instruments to build their own special-purpose systems.

"Building Block Method" is the term announced by Bailey Meter Co., Cleveland, Ohio for its new line of multi-purpose instruments and controls.

HAVE YOU RETURNED THE REQUEST CARD FOR THE 1957 MECHANICAL CATALOG

If you have mislaid your card, use the coupon for your convenience. Please fill this in and return it promptly to this office so that you may receive your copy of the Catalog when it is mailed in October.

Mr. C. E. Davies, *Secretary*

Please send me my copy of the 1957 Mechanical Catolog.
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Mechanical Catalog
American Society of Mechanical Engineers
29 West 39th Street
New York 18, N. Y.

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Laminated Tubing

Four-page illustrated brochure describes Tuff-Tube, new laminated fiberglas-epoxy tubing possessing properties not previously available in laminates. Brochure contains information on high temperature characteristics, electrical properties, weight, strength, etc., plus detailed technical data in accordance with ASTM testing procedures. Also included is illustrated section dealing with suggested applications of this material, of interest to designers in the aircraft, electronics, chemical, petroleum, and food industries.

Copies of the bulletin may be had by writing to Lamtex Industries, Inc., 51 State St., Westbury, L. I., N. Y.

Jet-Tray Deaerator

Cochrane Corp., 17th St., below Allegheny, Philadelphia 32, Pa., announces the availability of Publication 4651 describing a deaerator design that eliminates tubular vent condensers without impairing efficient purging of noncondensible gases. This type deaerator handles the widest range of operating conditions and provides maximum effective scrubbing contact between steam and water, thus assuring highly efficient oxygen removal.

Motor Catalog

A new two-color catalog sheet, illustrating and describing its new line of rectangular-shaped motors, has just been released by the Leece-Neville Co.

The motors, which are available with a 12-v capacity and outputs up to 115 oz-in., feature a special pole pattern which makes possible a flux path that is axial with the armature shaft, rather than concentric with the shaft as in conventional motors. Thus, the new motors, even though they are only $2^5/_{32}$ in. thick, give the same power output as comparable round motors.

All-welded construction, extra large bearings, welded heavy stampings which resist twisting, flexible installation, are some of the motors' principal features. Applications include window regulators, seat adjusters, air conditioners, wind-shield wipers, defrosters, heaters, car coolers, starting motors and pumps.

The free literature is illustrated with both photographs and engineering drawings; detailed specifications; operating information and representative performance data is likewise included. Copies may be obtained from the Leece-Neville Co., 1374 E. 51st St., Cleveland 3, Ohio.

Stainless Strip Steel

Technical information on 20 types of stainless strip steel is the subject of a 32-page brochure published by Superior Steel Corp., Carnegie, Pa.

The various types are analyzed to present recommended applications; general description; chemical, physical and mechanical properties; and corrosion resistance. Also included are tables on physical and mechanical properties of various metals and alloys, and on weight per lineal foot of strip steel of various thicknesses and widths.

Leather Cases

Bulletin 601, covering latest styles of leather cases, is available from Graton and Knight Co., Worcester, Mass.

Advantages of leather cases are cited as product protection assured by shock-absorbing leather, rich appearance of leather to upgrade the product, durable leather which improves with age. Six color photographs show leather instrument cases, radio cases, photographic equipment cases, consumer goods cases, government equipment cases and special leather cases for axes, slide rules, fire arms.

FOR EFFECTIVE SPRAYING AT LOWER COST

remember final control is the SPRAY NOZZLE you use!

In design . . . choose the Spray Nozzles that give you proper performance, with exact spray pattern, impact, spray angle and capacity. In application . . . be sure the nozzles as supplied are produced to close tolerances. Metallurgically, make certain the spray nozzles fit your use.

With Spraying Systems you can be sure of spray nozzles to meet all three requirements. ***Let Spraying Systems Co. recommend Spray Nozzles to meet your needs best.***

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Spraying Systems Co. Catalog No. 24 . . . 48 pages, with complete performance data. Write for your free copy.

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FOR EFFICIENT SPRAYING MAKE SURE THE NOZZLE IS RIGHT

SPRAYING SYSTEMS

NEW SPEED and SAFETY FOR PRODUCTION MARKING

Mecco SAFETY ROUND SHANK TYPE HOLDER

With the knurled shank designed to permit a firm, positive grip, the Model RS Type Holder is made of Mecco Safety Steel to eliminate mushrooming and spalling. The type is interchangeable, and the holder can be made for either one or two lines of type. Includes patented snap slide for quick changing of type.
Write for literature.

Mecco SAFETY MARKING TOOLS M.E.CUNNINGHAM CO.

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if your professional interest is in **missile development,**
you belong at Martin-Denver

For when you combine the challenging problems in our project of conquering outer space with the advantages of living in the colorful Rocky Mountain area . . . you will have the ultimate in realizing your professional aspirations.

The Martin Company invites you to TAKE ANOTHER LOOK at the real engineering opportunities in Denver, Colorado and *write to Emmett E. Hearn, Empl. Director, P. O. Box 179, Dept. C-6, Denver 1, Colorado*

MARTIN
DENVER DIVISION

TO THE MEMBERS OF—

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Members of the ASME are invited to name any number of engineers as candidates for membership. Engineering acquaintances should be qualified by both fundamental training and experience for one of the technical grades. Those who do not have an engineering degree may show the equivalent thereof through actual practice. Executives of attainment in science or industry may associate with the Society as Affiliates.

THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, and works to broaden the usefulness of the engineering profession.

As a post graduate school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

C. E. Davies, Secretary
The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

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Please send an application and information regarding ASME to the following:

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ME-8-56

PROBLEM:
how to produce true linear adjustment of the ratio between input and output in a 3-15 psi pneumatic system.

SOLUTION:
THE NEW HAGAN '3-15' RATIO RELAY

This unique Hagan device fills a long felt need in pneumatic process control systems for a relay which will permit the operator to adjust the *ratio* between input and output signals.

Rugged and reliable, and requiring small space, the Hagan Model '3-15' Ratio Relay produces a true linear proportional change in the output signal. Designed primarily for use with 3-15 psig signals, the '3-15' is easily adjusted to change the minimum input and output bias values to any point between zero and six psig. The actual maximum input and output signals may be any value up to 20 psig.

The Hagan '3-15' is ideally suited for any process control systems such as fuel to air ratio in combustion processes, ratio of gases in gas mixing or in the proportional feeding of chemicals. See your Hagan engineer, or write for full details. Ask for Specification Sheet SP4315.

HAGAN MODEL '3-15' RATIO RELAY

True ratioing around 3 psig input
Compatible with any signal system whose range is between 0 and 20 psig
Simple means for altering suppressed scale setting, if desired
Mounting Plate dimensions—6⅜" x 6⅜"
Input range—0-20 psig
Output range—0-20 psig
Minimum Ratio setting—0.3 to 1
Maximum Ratio setting—3.75 to 1
Suppressed Scale Range (adjustable)—0-6 psig

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HAGAN BUILDING, PITTSBURGH 30, PA.

Systems and Components for: Process Control, Metallurgical Furnace Control, Boiler Combustion Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

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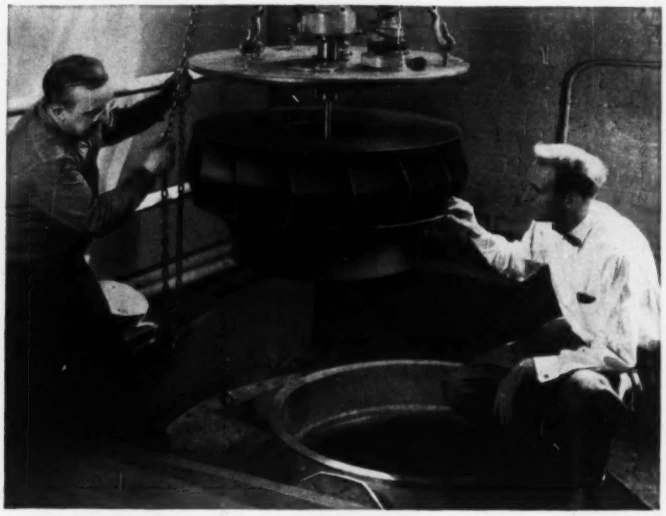
COMPLETE "BUFFALO" TESTING FACILITIES GIVE YOU THE LATEST AND BEST IN FANS

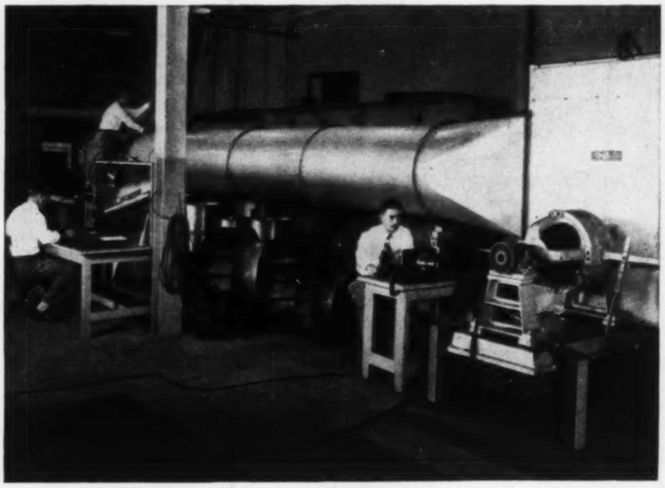
Such comprehensive testing — coupled with the fanmanship we've developed in 79 years — is your assurance of the "Q" Factor* in every "Buffalo" centrifugal, axial flow and propeller fan you order.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*



For greatest wheel strength, every wheel design must be tested at many times its operating speed. This is possible only in the "Buffalo" Vacuum Test Pit, where we literally spin wheels to destruction — discovering any weakness and correcting it. Thus, the "Buffalo" fans delivered to you have wheels capable of withstanding centrifugal force stresses far in excess of normal installed operation.

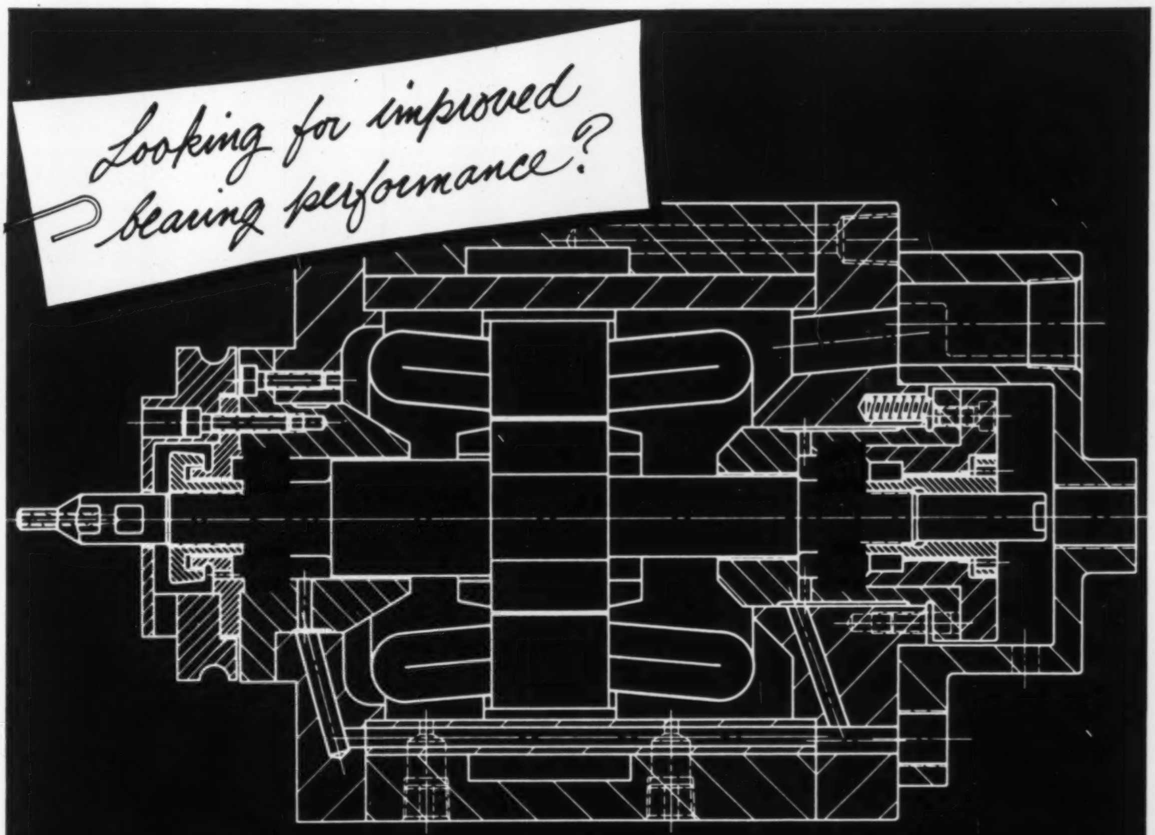
Performance tests. Continual testing of wheel and housing designs for noise and efficiency, from free air delivery to shutoff, result in ever-improved performance. All tests in the complete "Buffalo" laboratory are in strict accordance with ASH&VE, NAFM and PFMA test codes.



"Buffalo"

BUFFALO FORGE COMPANY
BUFFALO, NEW YORK
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



over 14 billion revolutions...

– and still going strong

Fafnir Super-Precision MM201W1-CR spring-loaded ball bearing, the type specified for wheelhead illustrated.

Fafnir-equipped, high-speed, oscillating grinder wheelhead demonstrates machine tool progress in performance

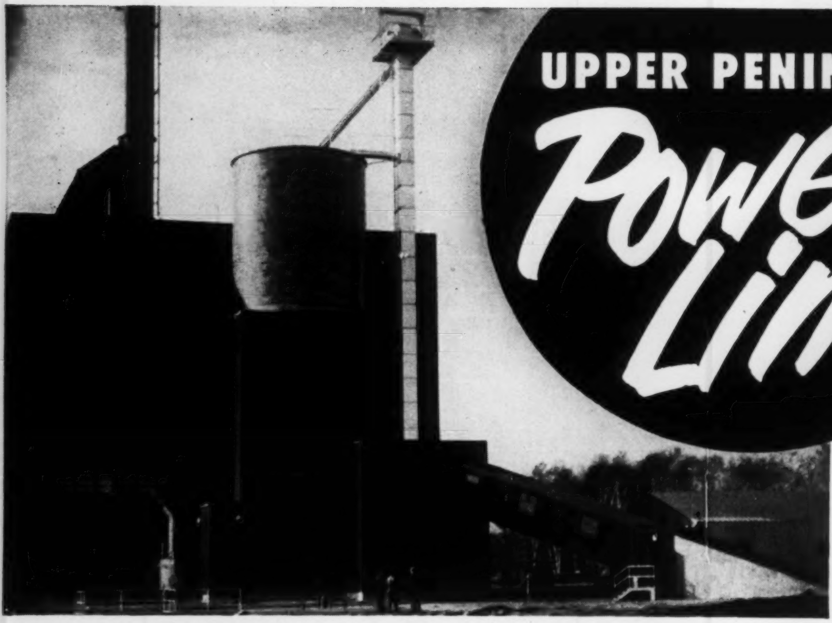
This extraordinary record has been made on the production line by a Pope-built wheelhead, grinding the races of extra-precision ball bearings. The hi-frequency motorized wheelhead operates at 72,000 rpm. The motor is water-cooled and bearings lubricated by means of an oil-air mist system.

When designing this oscillating grinder wheelhead, Fafnir engineers worked together with the Pope Machinery Company engineers in the selection and application of bearings. The type of bearing recommended is shown at the left and its application in the drawing above. Its performance record, according to Pope, demonstrates progress to match today's improved machine tools.

Whatever your bearing problem, a few minutes spent with a Fafnir representative may be the means of solving it as successfully. Write The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA



UPPER PENINSULA

Power Link

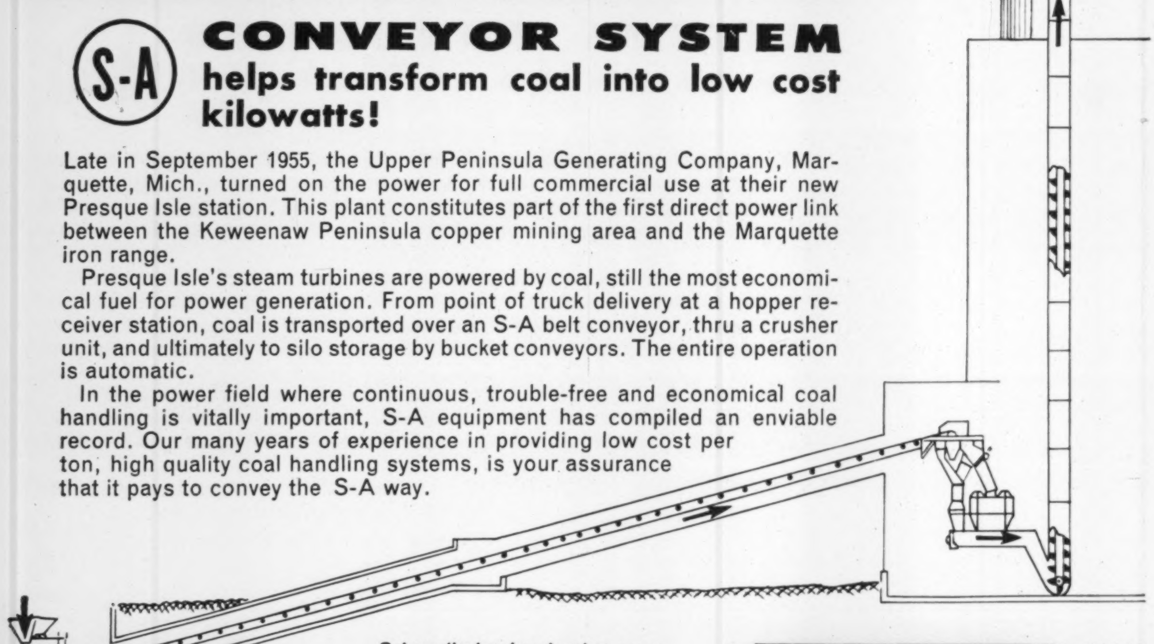
CONVEYOR SYSTEM

helps transform coal into low cost kilowatts!

Late in September 1955, the Upper Peninsula Generating Company, Marquette, Mich., turned on the power for full commercial use at their new Presque Isle station. This plant constitutes part of the first direct power link between the Keweenaw Peninsula copper mining area and the Marquette iron range.

Presque Isle's steam turbines are powered by coal, still the most economical fuel for power generation. From point of truck delivery at a hopper receiver station, coal is transported over an S-A belt conveyor, thru a crusher unit, and ultimately to silo storage by bucket conveyors. The entire operation is automatic.

In the power field where continuous, trouble-free and economical coal handling is vitally important, S-A equipment has compiled an enviable record. Our many years of experience in providing low cost per ton, high quality coal handling systems, is your assurance that it pays to convey the S-A way.



Schematic drawing showing complete Stephens-Adamson conveyor installation at Presque Isle.

S-A engineers work with consulting or staff engineers, with public utility or private power plant operations. We can assist the building contractor on new construction or can completely engineer and install your entire conveying system. Call S-A today. There is no obligation.

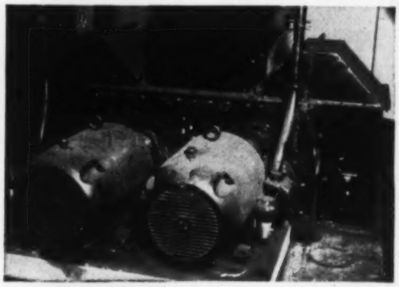
STEPHENS-ADAMSON MFG. CO.

19 Ridgeway Avenue, Aurora, Ill.
Los Angeles, Calif. — Belleville, Ontario

ENGINEERING DIVISION
Designers and manufacturers of all types of bulk materials conveying systems.

STANDARD PRODUCTS DIVISION
A complete line of conveyor accessories—centrifugal loaders—car pullers—bin level controls, etc.

SEALMASTER DIVISION
A full line of industrial ball bearing units available in both standard and special housings.



24″ x 24″ Double rotor knittel crusher reduces coal to $1\frac{1}{2}''$ to $\frac{1}{4}''$ size in one operation. Rotors rotate toward each other to permit reduction of larger lumps, with smaller diameter rotors, lower headroom, elimination of plugging.

A new perspective to Springmaking

Multiple sources for "Things" not called SPRINGS

Yours to put to work . . . . our mechanical ingenuity and craftsmanship . . . . experienced in producing an infinite variety of metal parts in such fields as automation, communication, medical, electronics, safety devices, product development, etc. The capacity of ASC springmaking minds and machines is unlimited. Ask any Division to examine your sample or blueprint.

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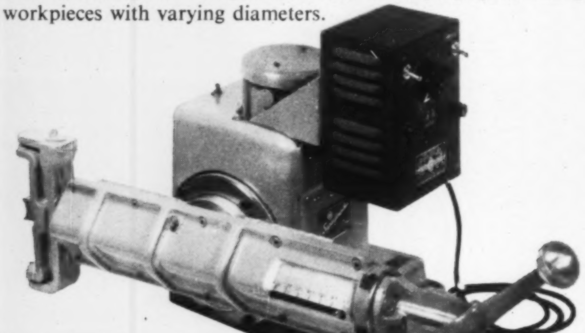
Variac® motor speed controls

. . . "*We use them with Confidence*"

Variac Motor Speed Control mounted on Gisholt No. 4 Superfinishing Attachment.

Speed control apparatus used with superfinishing and high-speed, metal-polishing equipment must be of the best for this is delicate, exacting work. Such speed controllers must be capable of smooth control over a wide range of speeds, and operation must be as dependable and trouble free as possible.

General Radio Variac Motor Speed Controls were designed for just this kind of service . . . and an increasing number of machine-tool manufacturers are finding this out. One such concern, the Gisholt Machine Company, now uses this motor control as standard equipment on all its Superfinishing Attachments to simplify speed changes on workpieces with varying diameters.



Type 1701-AK VARIAC Motor Speed Control, For 1/15 hp Shunt-Wound D-C Motors, Mounted on Gisholt No. 3 Superfinishing Attachment.

Motor control is equipped with Speed Control knob and dial, Forward-Reverse switch, On-Off line switch, 0-1725 and 0-3450 rpm switch, Slow-Blow Fuse, and Pilot Light. This compact unit is readily mounted on bench, wall, shelf, or assembled as an integral part of any machine.

Fifteen other Units from 1/15 hp to 1½ hp are available in both cabinet and stripped-down models. Prices range from $67 to $380. WRITE FOR THE VARIAC MOTOR SPEED CONTROL BULLETIN for complete data.

Leonard Hesse, engineer at the Gisholt Machine Company, has this to say of his Company's choice in motor drives:

> *"The Variac Motor Speed Control was selected after very thorough consideration with respect to available equipment. It fills our needs well.*
>
> *"Our prime requirement was that the drive be as reliable in operation as is possible. Low-speed performance was particularly important as our Superfinishing Attachments must be run at very low speeds for extended periods.*
>
> *"In conclusion, the compactness, simplicity and ruggedness of this particular piece of equipment would seem to make it useful in any kind of shop, and under all sorts of conditions. We feel we can use it on all types of Superfinishing applications with confidence — this includes single-piece set-ups as well as production runs."*

★ ★ ★

The G-R Variac Motor Speed Control is a motor drive which easily meets stringent specifications for performance and dependability. Advantages and Conveniences . . .

OPERATES D-C MOTORS FROM A-C LINES: plugs into ordinary 115 or 230-volt lines, converts this power to d-c, and provides all the advantages of d-c motor operation.

WIDE SPEED RANGE: at constant output torque.

EXTRA QUICK START-STOP-REVERSE: under heavy load conditions.

DYNAMIC BRAKING: on all larger models.

NO ELECTRON TUBES: selenium rectifiers make for ruggedness and reliability, require no warm-up time.

PERFECTLY SMOOTH CONTROL: from few rpm to rated speed.

LONG LIFE: with minimum maintenance; built-in overload protection prevents motor burnout.

GENERAL RADIO Company

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CATALOG 56
Zallea
EXPANSION JOINTS
WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

72-PAGE EXPANSION JOINT MANUAL

More than just another catalog. It is actually a complete and authoritative text that covers every phase of expansion joint design, construction, selection and installation.

Separate sections deal with the various types of Zallea Expansion Joints for absorbing axial, lateral and rotational movements.

New Zallea HyPTor Expansion Joints for high pressure applications are introduced.

Over 40 pages of tables and engineering data simplify expansion joint selection.

This manual is a must for any engineer having problems that involve the movement of piping due to temperature changes.

Write today, on your company letterhead, for your copy of Catalog 56.

Zallea *expansion joints*

ZALLEA BROTHERS 820 LOCUST STREET, WILMINGTON 99, DELAWARE
World's Largest Manufacturers of Expansion Joints

DIAGNOSIS:

knife wound in the heart

UNDER THE blazing blue sledge hammer of a Chicago heat wave, the cramped, makeshift operating room shimmered like an oven, reeking of ether and carbolic. Six sweat-drenched, frock-coated doctors huddled in fascination, watching deft hands reach into a human chest and expertly stitch up a wound in the redness of a pulsing heart.

Would he live? The surgeon mopped his brow and hoped. The year was 1893; the operation, fantastic.

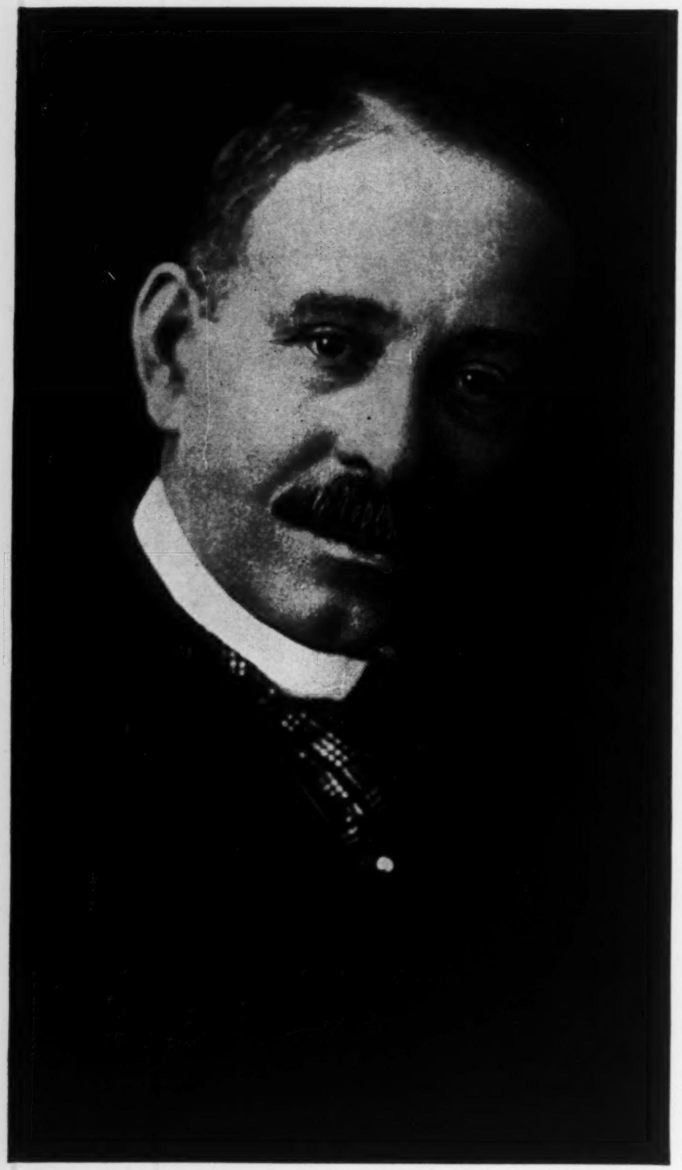
Live? Yes, he would live for many more years, thanks to the skill and courage of Dr. Daniel Hale Williams.

Abandoned as a child, Williams, a Negro, had struggled hard for his medical education. Now only 37, he had already founded America's first interracial hospital, Provident. And here he had just performed the first of the pioneering operations that would mark him as one of our country's great surgeons.

Sensitive and brave, Daniel Hale Williams was blessed with an abundance of the same urge to help his fellow man that binds and strengthens Americans today.

And it is these strong, unified Americans who are our country's real wealth—the real backing behind our nation's Savings Bonds. In fact, they're the true reason why U. S. Savings Bonds are considered one of the world's finest, safest investments.

For your own security—and for America's—why not invest in Savings Bonds regularly? And hold on to them!



It's actually easy to save—when you buy Series E Savings Bonds through the Payroll Savings Plan. Once you've signed up at your pay office, your saving is done *for you.* The Bonds you receive pay good interest—3% a year, compounded half-yearly when held to maturity. And the longer you hold them, the better your return. Even after maturity, they go on earning 10 years more. So hold on to your Bonds! Join Payroll Savings today—or buy Bonds where you bank.

Safe as America – U.S. Savings Bonds

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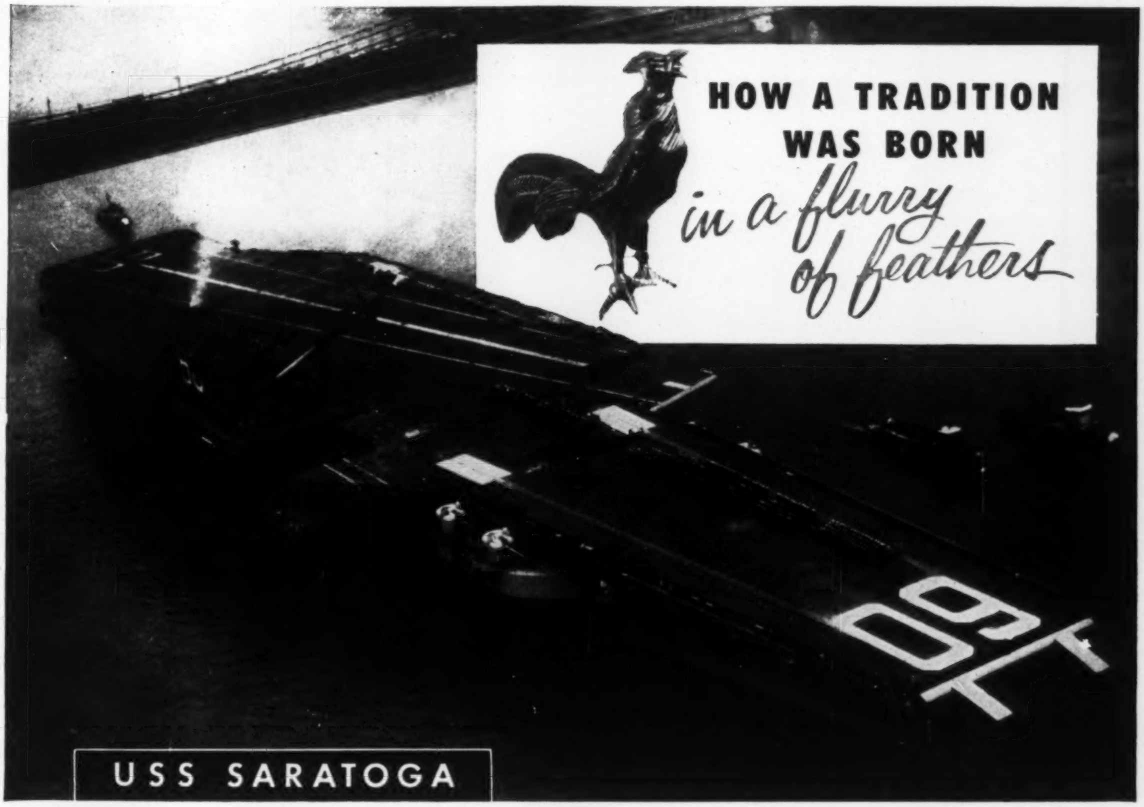


The symbol, and the spirit, of the fighting gamecock lives on with the commissioning of the powerful aircraft carrier, *USS Saratoga*.

The incident which gave birth to this 142 year old Navy tradition took place on the decks of the first *Saratoga* as she closed for action against four men-o'-war in 1812. In the opening minutes of the engagement an enemy ball landed on deck – crashing into a coop containing a gamecock brought aboard by a sailor.

With a flurry of feathers, the startled bird flew to the rail and, as if expressing his personal indignation, crowed lustily and defiantly. Taking this as an omen of good luck, the outnumbered and outgunned American ship entered the battle with new courage and completely won the day.

The Navy's newest aircraft carrier is the fourth ship to bear the name *Saratoga* and adopt its fighting symbol. As aboard its sister aircraft carriers, the USS Forrestal, USS Independence*, and USS Ranger*, Walworth Valves and Fittings are installed. We are proud of the many contributions that our products and engineering skills have made to these outstanding vessels.

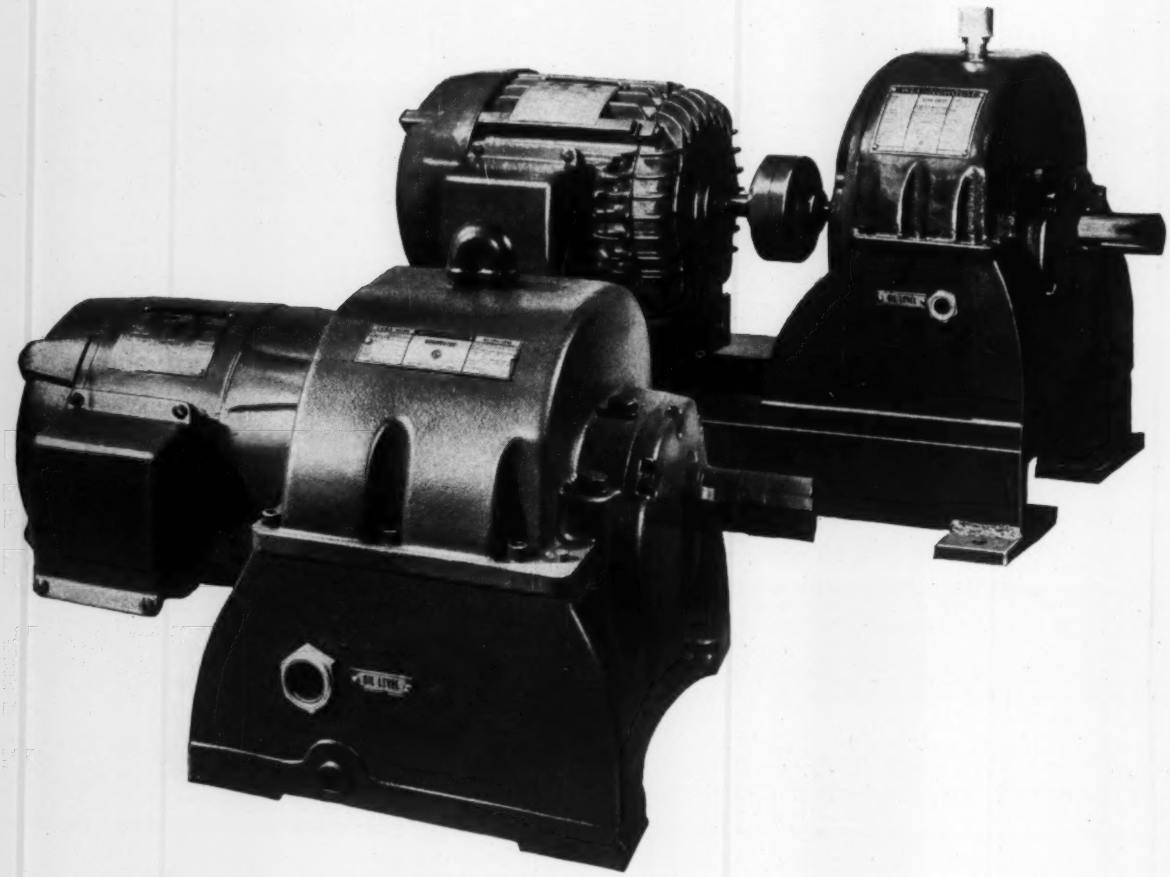
Walworth products installed aboard these ships include Pressure-Seal Cast Steel Gate, Globe, and Angle Valves, Fabricated Cast Steel Manifold Valves, Cast Steel Y-Globe and Angle Valves, Bronze Gate, Globe, Angle, and Check Valves and thousands of Walworth pipe fittings including Walseal® Fittings, Flanges, and Unions.

*Now under construction.

WALWORTH

60 East 42nd Street, New York 17, New York

SUBSIDIARIES: ALOYCO ALLOY STEEL PRODUCTS CO. Conoflow CONOFLOW CORPORATION M&H M & H VALVE & FITTINGS CO. SW SOUTHWEST FABRICATING & WELDING CO., INC. W WALWORTH COMPANY OF CANADA, LTD.



GEARMOTOR OR PACKAGED DRIVE?

Your selection has a longer future with Westinghouse BPT gearing

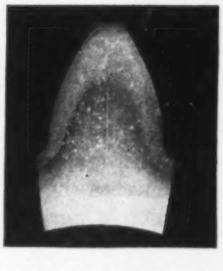
Westinghouse gearmotors and DB packaged drives offer important advantages to simplify drive problems and provide long-range dependability.

First, you'll find both lines of gearing readily available. They provide a wide selection in horsepower, speed ratios, direction of power take-off, mounting and coupling methods. This sort of flexibility is bound to save you time in answering space and load problems.

Second, Westinghouse BPT gearing, in both lines, assures a long-range solution to any drive problem. The exclusive BPT heat-treatment process produces unmatched, long wearing, shock-resistant qualities as a result of taper hardening each gear tooth. Heavy-duty, antifriction bearings also insure continued high efficiency under changing load demands.

Get all the facts on Westinghouse gearmotors and DB packaged drives today from your local Westinghouse salesman; or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-07351

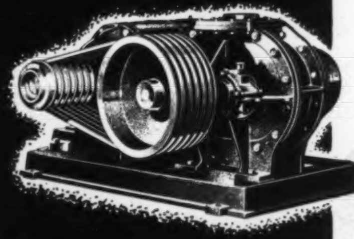


Exclusive BPT heat-treatment produces a taper hardness from surface to core of each gear tooth for toughness and hardness.

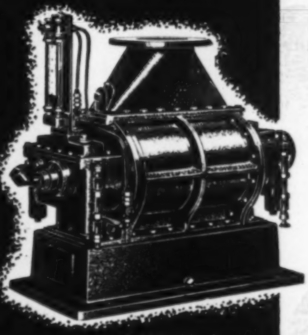
WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

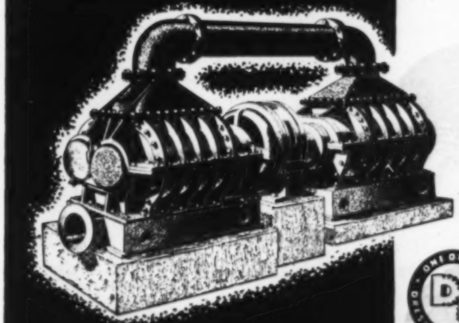
CENTRIFUGAL or Rotary Positive Blowers and Exhausters can move from 5 cfm to 100,000 cfm of air for many diversified needs. For complete details, send for Bulletins 120-B-14, AF-154 and RB-154.



GAS PUMPS can be applied to many industrial uses where from 5 cfm to 50,000 cfm are needed. Send for Bulletins 31-B-17 and 32-33-B-13 for full information.



METERS measure gas up to 1,000,000 cfh or as little as 4,000 cfh with constant accuracy. For specifications and capacity tables, send for your copy of Bulletin M-152.



VACUUM PUMPS with exceptionally low operating cost range in capacity from 500 cfm to 13,000 cfm, and up to 24" Hg vacuum. Complete information in Bulletin 50-B-13.

Production roadblocks avoided by ingenious use of air or gas

Alert industrial engineers and designers are finding new ways to put gas and air to work more effectively. They take delays out of industrial processing and improve quality. They add new utility to devices and appliances for commercial and home use.

...in many different applications

they are utilizing the many advantages of Roots-Connersville equipment. They move large or small volumes of air and gas with Blowers, Exhausters and Gas Pumps ... produce vacuums ... meter gas for proportioning or other measuring needs ... protect plants against fire and explosion with Inert Gas Generators. Solutions of specific problems are often solved faster and better when

...assisted by Roots-Connersville ideas

These are the result of more than 100 years of knowledge and are available to any user of gas or air, or equipment builders who need them. If you have a product or a process which might be improved by our mutual effort, we'll gladly work with you.

Just address:

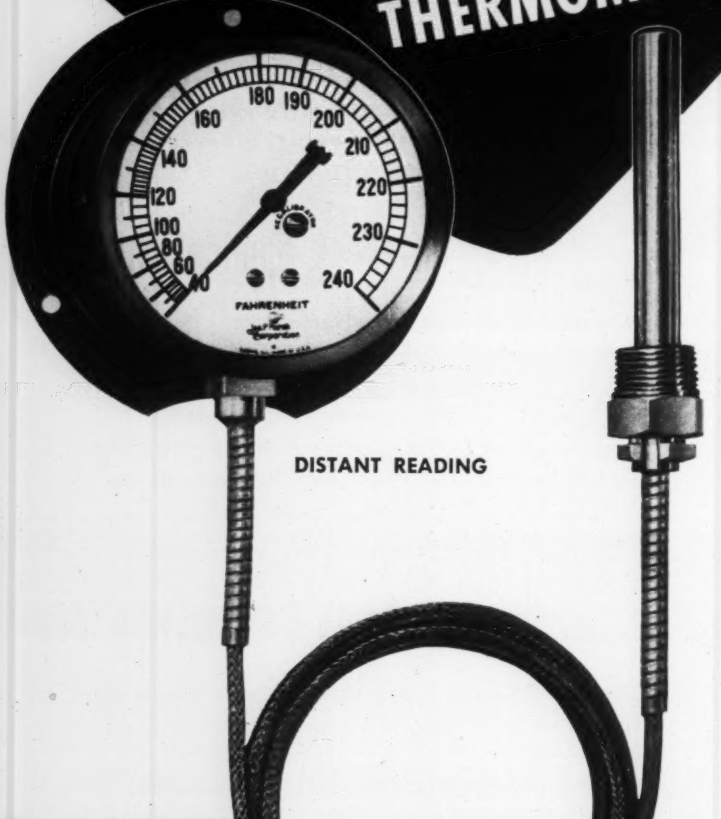
Product Development Manager, Roots-Connersville Blower Division
856 Michigan Avenue, Connersville, Indiana

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

MARSH

Vapor Tension DIAL THERMOMETERS



DISTANT READING

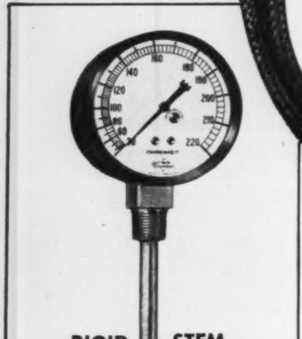
Wider range of application

...TIME PROVED MARSH QUALITY

The best of all we have learned in 90 years of instrument making has gone into Marsh Dial Thermometers. They are the versatile, vapor tension type—the type that covers the widest range of needs . . . brought to the highest stage of development in the broad Marsh line.

Ambient temperatures have no effect on dial readings of Marsh Vapor Tension Thermometers. Therefore no compensating adjustments are ever needed. The distant reading type will give highly accurate readings even when located far from the point of temperature measurement. All thermometers have the famous Marsh "Recalibrator"—quickest and best way to keep an instrument accurate.

The Marsh line is the most complete line: Rigid stem thermometers are available in dial sizes of 2½", 3½" and 4½"; distant reading types in sizes of 2", 2½", 3½", 6", 8". All are made in 12 different ranges reading as low as —40° F. and as high as 350° F., and in scale lengths to cover all services. An outstanding contribution to their practical application is the wide range of bulb types available to suit all services. Cases are available in patterns for all mountings and in black steel, polished brass, nickel and chromium plate.

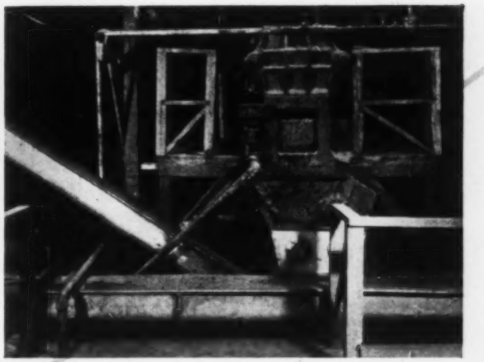


The JAS. P. MARSH *Corporation*
SKOKIE ILLINOIS
90th ANNIVERSARY YEAR
1865 · 1955

Catalog covers all details—
types, ranges, case patterns, dimensions, bulb variations, dial graduations. Write for it.

MARSH INSTRUMENT CO., *Sales affiliate of Jas. P. Marsh Corporation*
Dept. 29, Skokie, Ill.
Marsh Instrument & Valve Co., (Canada) Ltd. • 8407 103rd Street, Edmonton, Alberta, Canada

by conveyor belts



by spiral conveyors

If you move materials

by bucket elevators

by scraper conveyors

JEFFREY offers you

equipment incorporating the know-how gained in three-quarters of a century of studying and solving material-handling problems. Today, in thousands of plants throughout the world, Jeffrey conveying equipment is depended upon to maintain high production schedules, lighten the burden of labor and reduce operating costs.

Write for Catalog 860 describing Jeffrey material-handling and processing equipment. For high quality parts matching those originally installed on your equipment, get in touch with a nearby Jeffrey distributor or The Jeffrey Manufacturing Company, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT
TRANSMISSION MACHINERY • CONTRACT MANUFACTURING

TREMENDOUS, NEW FIELD OF OPPORTUNITY

NUCLEAR AIRCRAFT DESIGN AND DEVELOPMENT

Convair in San Diego offers challenging and very rewarding positions to engineers and scientists in the long-range program of development of *nuclear powered aircraft* for the U.S. Navy.

Graduate Mechanical, Civil, Marine, Chemical Engineers, Physicists and Naval Architects *without* aircraft experience are invited to join the important program of construction and operation of NUCLEAR DEVELOPMENT FACILITIES and operational and handling concepts.

Aerodynamic, Dynamic, Hydrodynamic, Nuclear, Propulsion Engineers and Aircraft Designers will enjoy tremendous growth potential at all experience levels through participation in the design and development of NUCLEAR POWERED AIRCRAFT.

To join this *new team* within our engineer's engineering department, write at once. Address resume to H. T. Brooks, Engineering Personnel, Dept. 620.

C-V **CONVAIR** GD

A DIVISION OF GENERAL DYNAMICS CORPORATION

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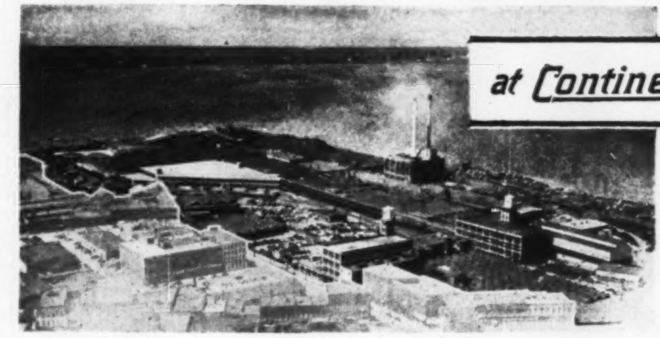
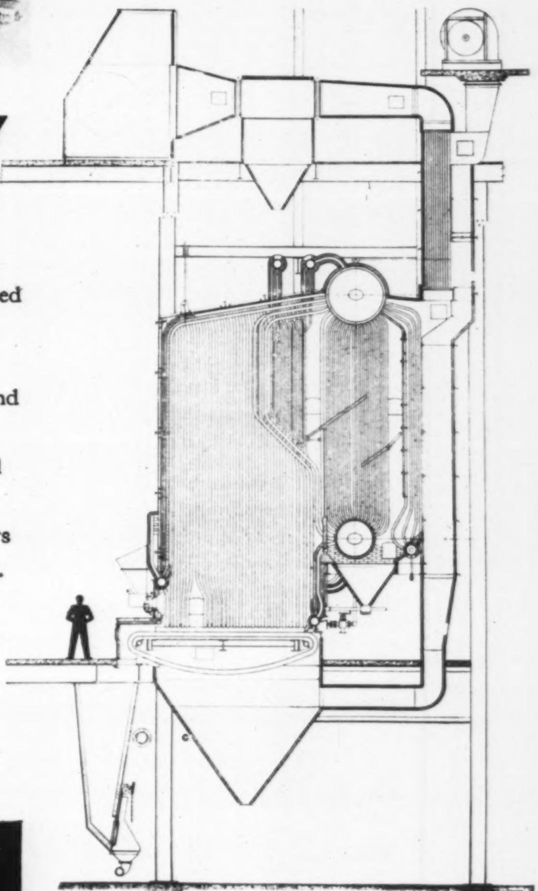
ERIE CITY Steam Generators



at Continental Motors Corporation

Roland W. Berger & Associates
Mansfield, Ohio
Engineers



ONE RESPONSIBILITY for all Major Components

The recent installation of modern Erie City 2-Drum Steam Generators at this Muskegon, Michigan plant provided "Undivided Responsibility" for Continental Motors Corporation. All the major components of these 100,000 lbs./hr. generators, including the boilers, air heaters, superheaters and stokers, were engineered and manufactured by Erie City Iron Works. Erie City also erected these generators and will provide any future service that is required.

Here at Erie City each component of our steam generators is designed to complement the other for maximum economy. Each component is engineered to meet specific performance requirements and to guarantee the highest efficiency. These and many more benefits are yours when you purchase complete steam generators by Erie City Iron Works. For a quick picture of our complete line of steam generating equipment write for Bulletin SB-5044.

data:

BOILERS, 2-DRUM • **2 E. C. 100,000 lbs./hr.**
Design pressure: 700 p. s. i. g.
Total steam temperature: 750° F.
AIR PREHEATERS • **2 E. C. Single Pass**
SUPERHEATERS • **2 E. C. Pendant Type**
SPREADER STOKERS • **2 E. C. "Travagrate"**

ERIE CITY
116 Years in Steam Generation

You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

LOOK

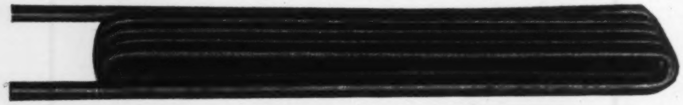
FINS actually E-X-T-R-U-D-E-D from the Tube Wall!

The fact that its fins are part of the tube wall is the secret of the construction of Wolverine Trufin*. It's the secret too, of the amazing performance records which Trufin-tubed heat exchange units are hanging up every day.

Because the fins and tube are all one piece, you are assured of constant efficiency. Fins are not impaired by vibration, temperature change or varying pressure. Trufin transfers *more* BTU's per foot of tube—permits you to design more compact units—steps up the capacity of existing ones.

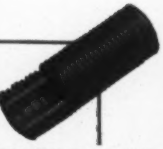
Trufin is fabricated as easily as plain tube, too. In fact, standard tools and techniques are used. Fabricated Trufin units are often stronger than units using plain tube because fins provide additional support at bends. You can obtain more information by writing for Wolverine's Trufin Application Book, "Opportunities Unlimited". Remember: You can *depend* on Trufin for *dependable* heat transfer! Wolverine Tube, 1483 Central Avenue, Detroit 9, Michigan.

*REGISTERED U. S. PATENT OFFICE

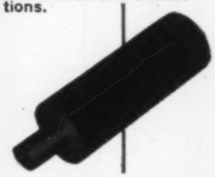


and actually FABRICATED as READILY as Plain Tube!

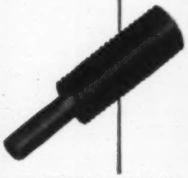
TRUFIN TYPE S/T
for shell and tube heat exchanger and condenser applications.



TRUFIN TYPE H/A
integral copper or aluminum finned tube with controlled I.D. to facilitate brazed end connections.

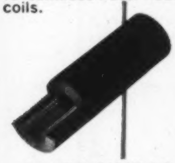


TRUFIN TYPE L/C
a bimetallic tube for air-cooled condensers or coolers.



TRUFIN TYPE H/R
unexcelled for air or gas heat exchangers or condensers.

TRUFIN TYPE W/H
for tankless water heater coils.



TRUFIN TYPE I/L
an all aluminum tube with normal Trufin fins on the outside of the tube and longitudinal fins on the inside.

SIX TYPES

DIVISIONS OF
CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
CANADA VULCANIZER
& EQUIPMENT CO., LTD.
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WOLVERINE TUBE
Division of Calumet & Hecla, Inc.
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Wolverine Trufin is available in Canada through the Unifin Tube Co., London, Ontario.

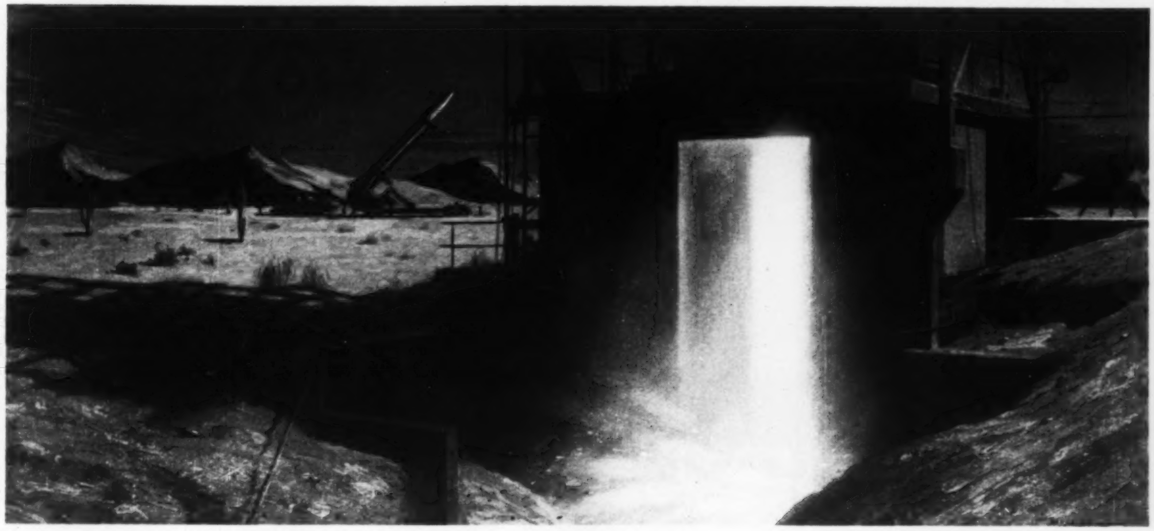
5373

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK.

Notable Achievements at JPL

THE CORPORAL ROCKET ENGINE, developed at JPL, represents the first large-scale American engine to be used in a tactical guided missile and the first significant step in the design of truly lightweight, large-scale rocket engines. The reliability of the Corporal engine has been proven in hundreds of static tests and flights.



Pioneers in Rocket Engine Development

JPL JOB OPPORTUNITIES ARE
WAITING FOR YOU TODAY
in these fields

AERONAUTICAL
·
MECHANICAL
·
STRUCTURAL
·
DYNAMICS
·
PROPULSION
·
APPLIED MECHANICS
·
INERTIAL ELEMENTS
·
CONTRACT LIAISON
·
TECHNICAL EDITING
·
TECHNICAL WRITING

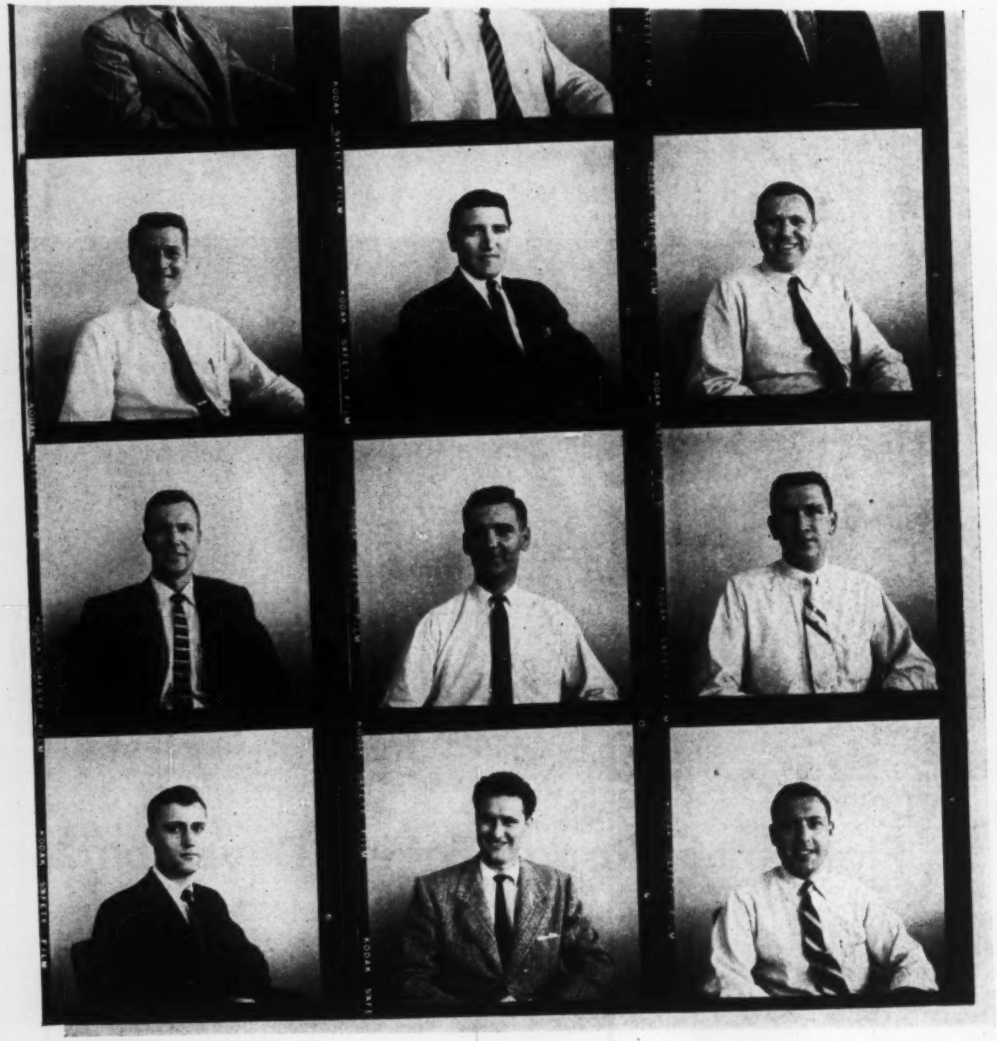
The development of efficient rocket power plants involves application of knowledge from many scientific and engineering fields—thermodynamics, combustion, heat transfer, fluid mechanics, and metallurgy, to name a few. Such development stems from experience gained with small engines and progresses through various phases, including component development, heat transfer investigation and exhaustive firing of the final engine to assure reliability and repeatability of operation.

The prime objective of JPL is obtaining basic information in the various sciences related to missile systems development and in all phases of jet propulsion. As a basis for the entire Laboratory activity, a major continuous program of fundamental research in the physical sciences is constantly in progress.

The Laboratory, occupying an 80 acre site in the San Gabriel mountain foothills north of Pasadena, is staffed by approximately 1450 people, all employed by the California Institute of Technology. Its various projects are conducted under continuing contracts with the U. S. Government.

Expanding programs are rapidly providing new openings for qualified people. If you would enjoy the challenge of new problems in research, write us today outlining your interests, experience, and qualifications.

CALTECH jpl **JET PROPULSION LABORATORY**
A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA



Which one will qualify as a missile engineer?

All—or none—depending on three important points! The desire for a *real* engineering challenge. The ability to work with a top team of experts in their respective fields. The capacity to take on individual responsibility.

If this sounds like a lot, it's because North American Aviation has a lot to offer. With research, development and manufacturing responsibility for the U. S. Air Force SM-64 Navaho Intercontinental Missile, the scope of the art at North American is wide and the opportunity to assume a position of authority great. In fact, all phases of this project—research, design, development and testing—are being accomplished by North American engineers.

And what benefits will you find in this type of engineering environment?

First of all—recognition that comes from the opportunity for individual effort. You will work with engineers who respect your opinions and professional status. Because missile engineering covers so many fields, you can work in the area of your choice. You will work on a team of specialists whose leadership in their fields will further you in the one you choose. You will live in Southern California and receive financial compensation limited only by your own ability.

If you have the desire for a real engineering challenge—Investigate Now.

Contact: R. L. Cunningham, Engineering Personnel Office
Dept. ME, 12214 Lakewood Boulevard, Downey, Calif.

NORTH AMERICAN AVIATION, INC.

See this NEW BJ NUCLEAR PUMP in operation

QUICK FACTS ON THIS BJ NUCLEAR DISPLAY PUMP

- **Compact, Easily Handled**... overall dimensions are only 6" x 8" x 36". Weighs approximately 55 lbs.
- **Self-contained**... no special set-up required.
- **Electrically Operated**... operates on 110 volts, 3 phase, 60 cycles or 220 volts, 3 phase, 60 cycles. A transformer is supplied when it is necessary to change 220 volts to 110 volts. Power lead-ins are provided for connection with a junction box.
- **Authentic**... this pump duplicates an actual BJ nuclear pump—demonstrates the basic principle and operation of all "liner" type pumps.
- **Completely Safe**... water is used as the demonstration fluid and all moving parts are enclosed.
- **Shipping Container Provided**... easily repacked in its shipping container for return after use.
- **No Obligation Involved**... display is offered without charge to qualified groups. Availability is, of course, based on "first request" scheduling.

ACTUAL PUMP AVAILABLE FOR STUDY... WITH OPERATING PARTS IN FULL VIEW

BYRON JACKSON has designed a special display version of this new BJ liner motor pump for demonstration to engineers and technical personnel. This pump duplicates one of the BJ designs now in use in the field. However, transparent lucite has been substituted for the center pump housing to permit observation of the special construction used in this unit.

The observer is able to watch the circulating fluid as it moves from the pump through the heat exchanger and on through the flow indicator and expansion chamber before returning to the pump section.

Byron Jackson is happy to make this compact, portable unit available to qualified engineering departments, associations, schools and other interested groups for study. Arrangements to see this display pump can be made by writing:

Byron Jackson pioneered many of the basic developments in nuclear pumping and this rich fund of specialized nuclear engineering is available to help solve your pumping problems in this field.

BJ
SINCE 1872

Byron Jackson Pumps
INC.
A SUBSIDIARY OF BORG-WARNER CORPORATION
P. O. Box 2017A, Terminal Annex
Los Angeles 54, California

Builders of Future America

Excerpts from a recent address by Roger M. Blough, Chairman of the Board, United States Steel Corporation

"Somewhere in this day's twilight there is a boy sitting alone. He may be your son or a neighbor's son. He is thinking about his most pressing obligation – what to do with his life, what to make of himself.

"Out of nowhere, perhaps, will come the realization that he will find personal growth and confidence and the full life if he can only make a plane that will fly better in the air, or a machine that will run better on rails, or if he can make a device to lessen human drudgery in the home, or build a home so beautiful and so full of human satisfaction that it will excel all that has gone on before.

"For this boy . . . the answer may lie in the insatiable demands for fuel from under the ground and for power to turn the wheels of industry. Or for him, a deep-seated satisfaction may come from learning and knowing that the unfathomable atom can be harnessed.

"Somewhere in that young valiant mind . . . will emerge the image of men of science and men of engineering who became what they are . . . in the dedicated hope that their chosen career may afford them at least one fleeting moment of major achievement.

"That boy, though he may say little, will see in you, and the others like you, the builders of America. And when he sees that much, every thoughtful boy . . . will see a little more. He will see himself grasping your work, building mightly upon what you have built . . . He will see the great challenge of America for his own work and for his own life."

Today, when every effort is being made to focus public attention on the acute shortage of technical manpower, these excerpts from Mr. Blough's address are especially timely. They are printed here in the hope that they will remind Fathers – thinking of their son's careers – of the challenging opportunities the America of tomorrow offers men trained in the fields of science and engineering.

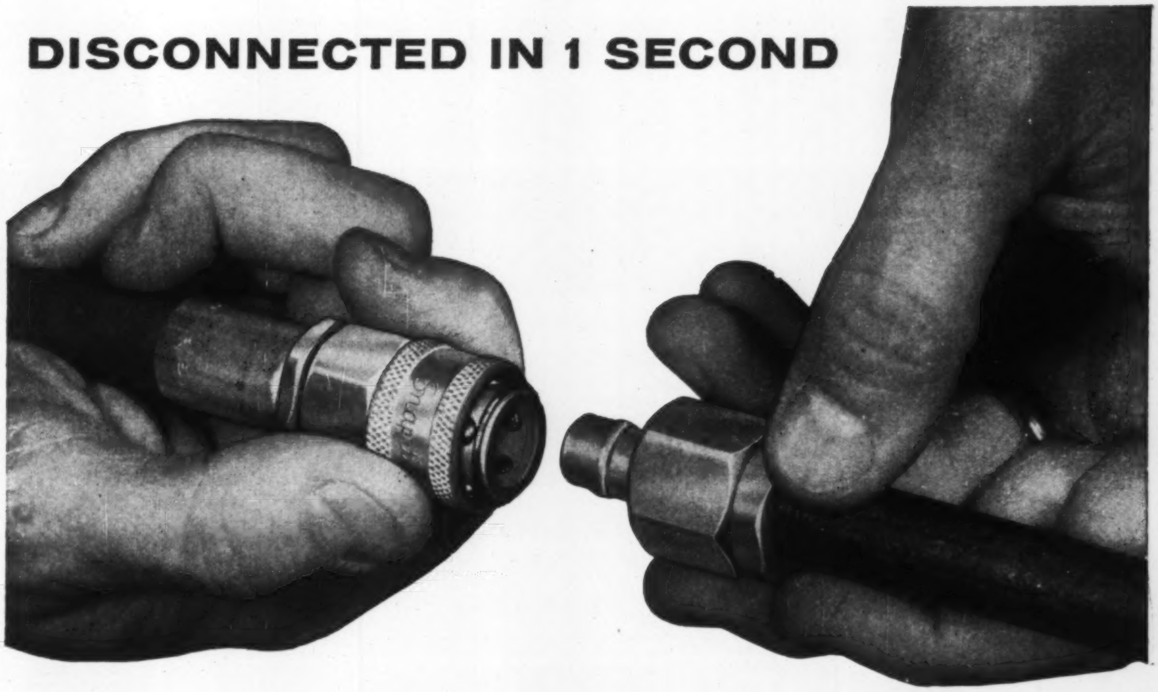
COMBUSTION ENGINEERING, INC.

B-925

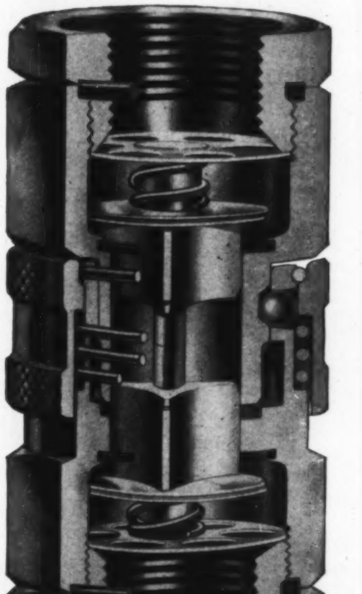
200 Madison Avenue, New York 16, N. Y.

Steam Generating Units • Nuclear Reactors • Paper Mill Equipment • Pulverizers • Flash Drying Systems
Pressure Vessels • Home Heating and Cooling Units • Domestic Water Heaters • Soil Pipe

DISCONNECTED IN 1 SECOND



and NO DANGEROUS SPRAY



INSTALL SNAP-TITE "H" COUPLINGS:

- Snap-Tite "H" Series couplings are constructed so that the valve is completely closed in coupler before disengaging the nipple seal, eliminating fluid spray, and the only loss of fluid is the few drops in the nipple cavity.
- Powerful springs keep valves shut tight when "H" couplings are disconnected.

Check your couplings. Are they creating accident hazards and losing costly fluids? Are offensive odors and flammable gases escaping from them?

SNAP-TITE'S "H" COUPLING, SIZE FOR SIZE, IS THE SMALLEST COUPLING WITH HIGHEST STRENGTH AND HIGHER EFFICIENCY

Recessed valve washers . . . fluted valve stems . . . valve stops with minimum flow restrictions . . . large inside diameter—these combine to allow maximum flow capacity with lowest pressure drop.

Available in sizes ⅛" to 10" in alloy steel or to specifications

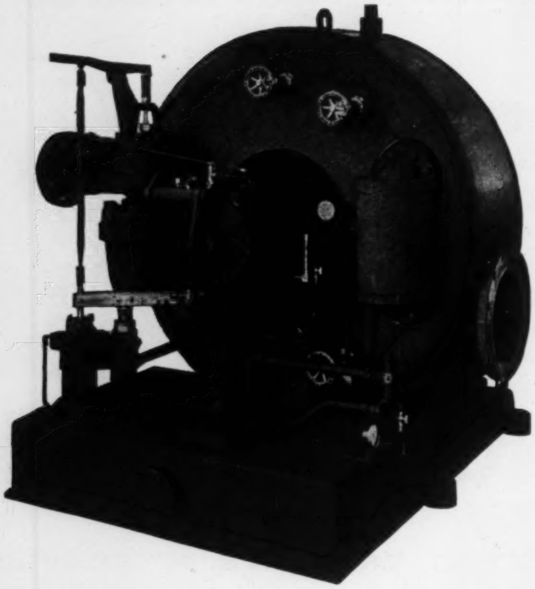
SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

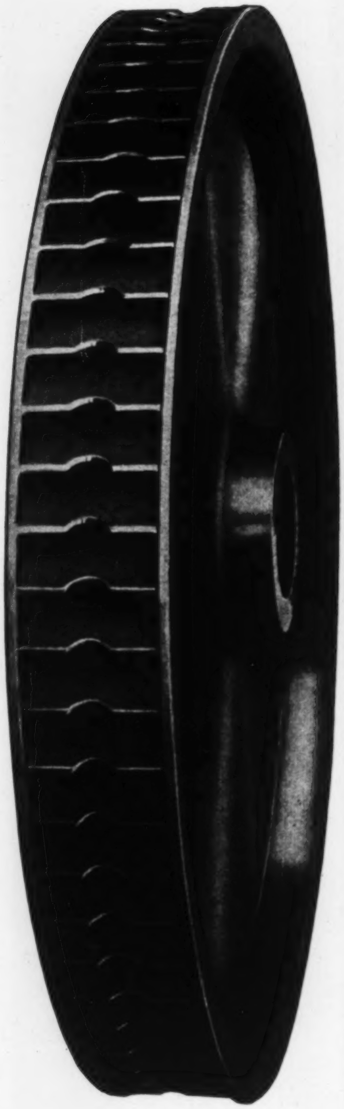
See the Snap-Tite representative in your city or write for Bulletin 240A

Snap-tite, INC.
UNION CITY • PENNSYLVANIA

TROUBLE-FREE TURBINE OPERATION STARTS

HERE





Terry solid wheel turbines have become a symbol for dependable, trouble-free operation. The reason—simplicity and ruggedness of construction.

Take the rotor, for instance. It's a solid forging in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. Since the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

Simplicity outside too—as you can see from the photograph of the 1500 HP at 3500 RPM solid wheel turbine above. This turbine is equipped with an oil relay governor and forced feed lubrication to the bearings.

For more about these *work horses of industry,* send for a copy of bulletin S-116. No cost or obligation.

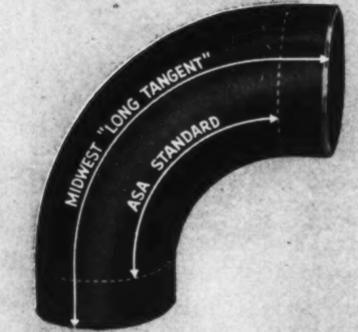
THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1200

THESE MIDWEST "LONG TANGENT" ELBOWS SAVED $4121 IN PIPE



MIDWEST "LONG TANGENT" ELBOWS COST NO MORE THAN OTHER ELBOWS

Here are 1227 Midwest "Long Tangent" Elbows (12", 14" and 16" standard weight) ready for shipment to a chemical plant. Each Midwest "Long Tangent" Elbow has a straight section on each end equal in length to ¼ the nominal pipe size. Thus a 12" elbow saves 6" of 12" pipe while a 16" elbow saves 8" of 16" pipe. It doesn't take long to save a lot of pipe and a lot of money . . . in this instance $4121.

But saving pipe is not the only advantage of Midwest "Long Tangent" Elbows. They often eliminate short nipples and their extra welds . . . save time and money in lining up and clamping pipe and fittings . . . slip-on flanges are more easily applied. For all the facts, write for Catalog 54.

MIDWEST PIPING COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Clifton, N. J. Los Angeles and Boston

Sales Offices
New York 7—50 Church St. • Chicago 3—79 West Monroe St.
Boston 27—426 First St. • Los Angeles 33—520 Anderson St.
Houston 2—1213 Capitol Ave. • Tulsa 3—224 Wright Bldg.
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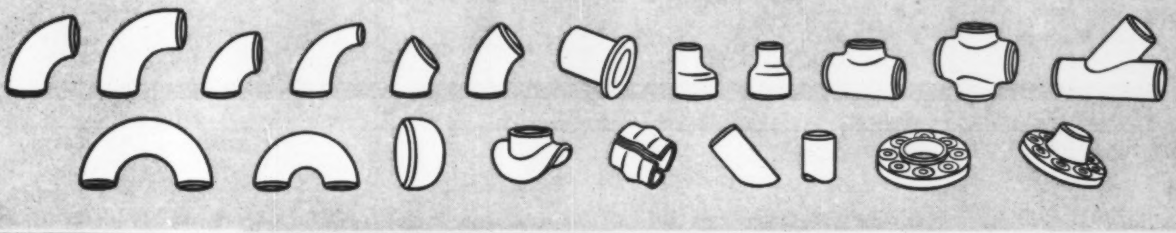
STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

MIDWEST WELDING FITTINGS

MIDWEST WELDING FITTINGS Improve Piping Design and Reduce Costs



7055

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22nd NATIONAL EXPOSITION of POWER & MECHANICAL ENGINEERING

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If POWER—its production and use—is related to your products and services, here's the one exposition you shouldn't miss. Thousands of mechanical engineers, executives and production men will be viewing the hundreds of absorbing exhibits . . . and if yours is among them, you'll be in on one of the year's best selling opportunities! There's no more dramatic or effective way of selling your products and new ideas than by an exhibit at this great exposition.

What makes the Power Show such a prime opportunity? For one thing, it's held in conjunction with the annual meetings of ASME—key engineers and operating men who are important factors in specifying and buying power and allied equipment will be there. And—the exposition is being held in NEW YORK, in the world's newest, most modern exposition hall, the COLISEUM. Convention-going (and exhibiting) will be easier in the convenient, *air-conditioned* COLISEUM!

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22ND NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING

480 Lexington Avenue, New York 17, N. Y.

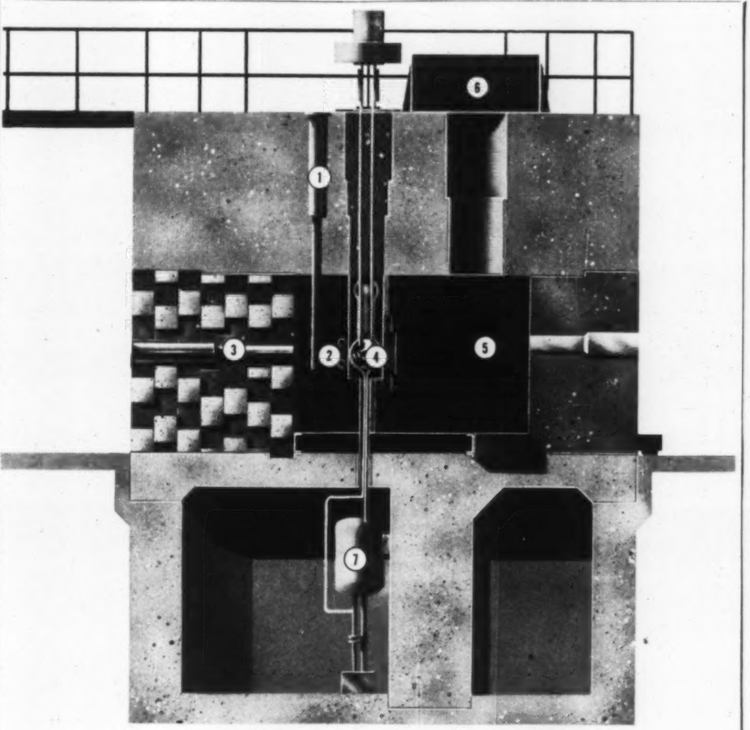
MANAGEMENT: INTERNATIONAL EXPOSITION COMPANY

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Aqueous, homogeneous type nuclear reactor being built for Japan

The first nuclear reactor for the Far East is being built by ATOMICS INTERNATIONAL for the Atomic Energy Research Institute of Japan. The reactor will be located near Tokyo. When the reactor starts operating early in 1957, a full program of research into the peaceful applications of nuclear energy will begin. This program includes the production of radioisotopes, studies in neutron activation, neutron diffraction, radiation effect on materials and training in reactor techniques.

At a rated power of 50 kilowatts, this solution type reactor will produce a peak thermal neutron flux of 1.7 x $10^{12}/cm^2$ sec. Equipped with a five foot graphite thermal column, it will provide an extensive source of slow neutrons. Additionally, the room beneath the reactor housing the gas handling system has been designed to provide neutron-free gamma irradiation. This facility, ideally suited for biological and chemical experiments, will provide 50,000 curies of radioactivity in Xenon and Krypton gases circulating in the system.



Solution Type Research Reactor for Japan.

1—Vertical thimble
2—Pneumatic tubes
3—Beam Tubes
4—Central exposure facility
5—Horizontal thermal column
6—Vertical thermal column
7—Gamma radiation area

The core of the reactor is a stainless steel sphere with a diameter of approximately 12 inches, filled with a uranyl sulphate solution. The fuel investment is approximately 1000 grams of Uranium^{235}. The reflector around the core consists of graphite stacked in a rectangular steel tank 5 feet high, 5 feet wide and 8 feet long. Appropriate holes for experimental facilities and instrumentation are located in the graphite. Five feet of dense concrete provides a shield around the reflector tank.

Instrumentation control is provided by two types of sensing elements which give neutron level information. In the power range up to approximately 1 watt, two fission chambers are employed. In the power range of approximately 0.1 to 50,000 watts, two gamma compensated ionization chambers are used. One of these chambers is fed into a shutdown channel and an electrometer which in turn sends a signal to the power level recorder. Power level is automatically maintained by feeding an error signal from the level recorder to a servo-amplifier which drives the regulating rod motor in the proper direction to correct error. The other ionization chamber feeds a logarithmic amplifier, and period shutdown circuit.

The core cooling system consists of a closed, recirculating system using demineralized light water. The core cooling loop includes about 90 feet of stainless steel tubing, the associated pump, valves and piping, and a heat exchanger to transfer the heat to a secondary cooling system.

ATOMICS INTERNATIONAL, a division of North American Aviation, Inc., is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. A reactor similar to the one scheduled for Japan has been installed for the Armour Research Foundation of the Illinois Institute of Technology in Chicago. It is one of several in-action nuclear reactors designed and built by ATOMICS INTERNATIONAL.

If you are interested in any phase of reactor technology, ATOMICS INTERNATIONAL is staffed and equipped to serve you. Please write: Director of Technical Sales, Department ME-N4, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

THIS COOLING TOWER HOUSING IS *fireproof,*
corrosion-resistant and virtually maintenance free

Cooling tower in photograph above constructed by Phillips Cooling Tower Co., Inc., Brooklyn, N.Y.

It's made of J-M Transite®

Corrugated asbestos-cement sheets

Johns-Manville Transite offers many outstanding advantages for constructing cooling tower housings. This time-tested material provides the ideal combination of properties needed for such rugged service.

It's Fireproof—Completely inorganic, Transite can't burn or support flame . . . greatly reduces the ever-threatening hazard of rooftop fires.

It Resists Corrosion—Transite is unaffected by weather, moisture and most corrosive elements found in industrial atmospheres.

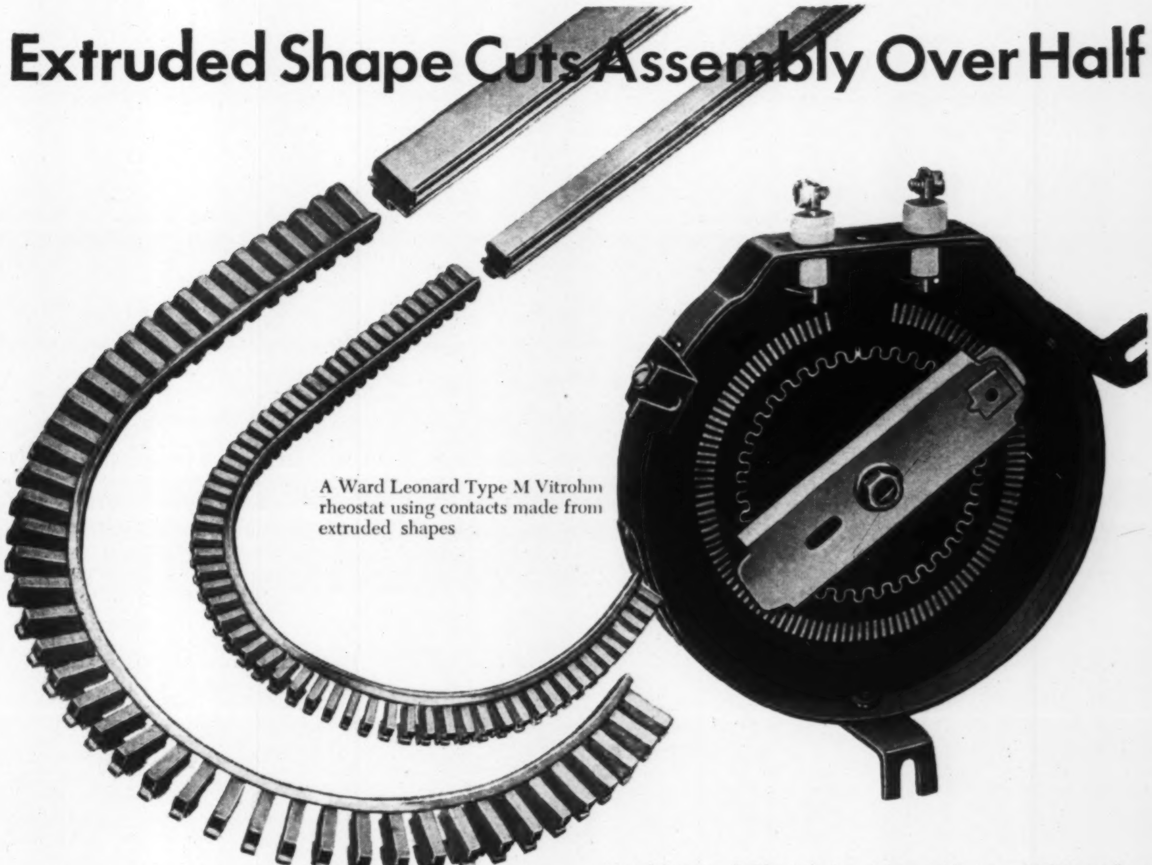
It needs no Maintenance—Transite never needs painting or other protective coating under normal operating conditions . . . its high strength provides long life.

It's Attractive—A soft natural grey in color, Transite blends perfectly with modern architecture. In corrugated or flat form, Transite towers make an attractive addition to most buildings.

Write for further information—For further data and names of manufacturers who can supply cooling towers made of J-M Transite, write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.

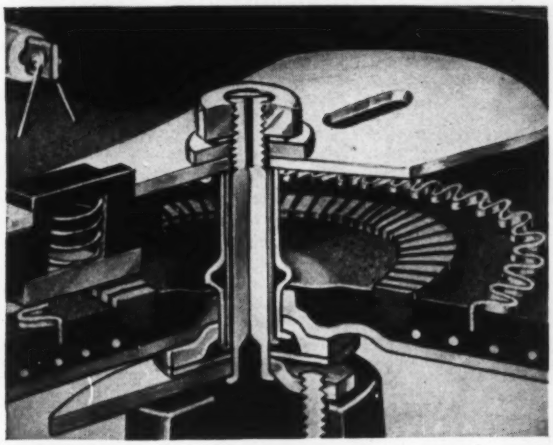
JOHNS-MANVILLE JM PRODUCTS **Johns-Manville TRANSITE** **THE MODERN MATERIAL FOR COOLING TOWERS**

Extruded Shape Cuts Assembly Over Half



A Ward Leonard Type M Vitrohm rheostat using contacts made from extruded shapes

Ingenious application eliminates hand assembly, makes absolutely uniform stationary contacts in Ward Leonard power rheostats



CROSS SECTION VIEW of a Ward Leonard Vitrohm Type S rheostat showing how contacts are embedded in a vitreous enamel.

Ward Leonard Electric Co., Mount Vernon, N. Y., makes a line of high quality power rheostats marketed under the trade-name Vitrohm. Anywhere from 41 to 161 individual stationary contacts, or buttons, have to be embedded with their resistance elements in an insulating vitreous enamel—all contacts uniformly set and spaced, for uniform performance. Their patented process originally used buttons blanked out of sheet brass—hand assembled and spaced on a steel wire to hold them while the vitreous enamel was fired.

Ward Leonard refined the process and for four models now starts with the extruded shapes shown above. The stock is accurately slotted for correct spacing, forming a continuous line of buttons connected by a triangular "wire"—which is an integral part of the extruded shape. When sections are curved, the buttons remain uniformly spaced and oriented. After the button assemblies are embedded in the vitreous enamel, the connecting wire is easily milled off. Ward Leonard gets absolute uniformity with less effort and fewer rejects—it gets healthy dollar savings, despite the fact that more than half of the extruded shape is milled out.

Imagination applied to extruded shapes can pay big dividends—lower direct labor costs—fewer machining operations—less scrap—improved product quality. Your Anaconda representative will be glad to work with you. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5584

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EXTRUDED SHAPES

Short cuts to a finished product

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HEAT

MATERIALS

there's an exceptional opportunity for you at Hughes.

There are many excellent openings for mechanical and aeronautical engineers for challenging assignments in the areas of high-speed missiles, aircraft structures, and antennas. This work concerns developing practical solutions to both theoretical and actual problems of heat transfer, structural analysis and design, stress analysis, materials section, and instrumentation.

The projects at Hughes have both military and commercial potential. Men qualified for these activities are assured of a practically unlimited future in a career with the West's leading center for advanced electronics.

You owe it to yourself to investigate this opportunity to earn a top salary while working with leading scientists and engineers in the ideal climate of Southern California. Mail us your resume to qualify for personal interviews.

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Culver City
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A few of our openings include:

ENGINEERS
For the analysis and design of missile structures and other airborne equipment. Also adhesives engineers, metallurgical and materials engineers with aircraft or missile design experience.

MECHANICAL ENGINEERS
To participate in the design and development of missiles, missile launchers, aircraft structure, component installation, environmental test equipment and general mechanical design.

AERONAUTICAL ENGINEERS
For the analysis and design of missile launching equipment for high-speed aircraft, including coordination and liaison with many major airframe manufacturers.

DYNAMICS ENGINEERS
To work on shock and vibration problems in an aerothermal environment. Also elasticians to work on advanced aerothermoelastic problems associated with high-speed flight.

ENGINEER
For research related to the selection of materials and development of fabrication techniques.

LIAISON ENGINEER
To work between Development Laboratories in Culver City and Engineering Laboratory in Tucson or between the Laboratory and subcontractors.

THERMODYNAMICIST
To perform analytical and experimental analysis of heat transfer from electronic components via natural convection, forced-air convection, and radiation.

These positions also available in the Research and Development activity at Tucson, Arizona.

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.

2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.

3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.

4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.

5. Sleeves carried on bearing rings, located on *transverse center line of hub spline faces* (the load-carrying surfaces) . . . no crank action, no vibration.

6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3408 Scott Street, Baltimore 3, Maryland.

THE ORIGINAL FAST'S Couplings

KOPPERS

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This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans.
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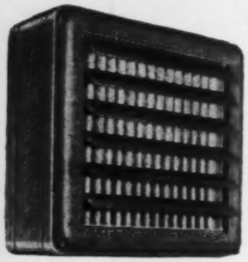
WHAT ARE YOU LOOKING FOR IN A UNIT HEATER?

Top performance? Quiet operation? Easy installation? Low cost? They're *all* yours when you choose from the American Blower Venturafin Unit Heater line. It is a *complete* line, available in all popular sizes, with capacities ranging from 18,000 to 560,000 BTU (at 2 lbs. steam pressure, and 60° entering air).

You'll find a choice of coils to fit your particular job requirements, too. Coils are available for use with high-temperature, high-pressure hot water; with low-pressure hot water; or with steam. All coils have high-quality non-ferrous fins, mechanically bonded to seamless copper (or steel) tubes for efficiency and durability.

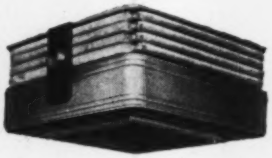
For your *next* heating job, choose the heaters that best fit your needs — American Blower Unit Heaters. They're backed by 75 years of industry leadership. For more information, contact your nearest American Blower Branch Office.

There's an American Blower Unit Heater for every job



HORIZONTAL HEATERS

For horizontal blow, select from a wide range of capacities: 18,000 to 357,500 BTU at 2 lbs. steam pressure and 60° entering air.

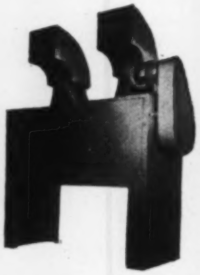


VERTICAL HEATERS

Equipped with exclusive ABC Equitemp Air Diffusers. Capacities: 58,400 to 560,000 BTU at 2 lbs. steam pressure and 60° entering air.

GAS-FIRED HEATERS

Available for natural, mixed, manufactured, LP, LP air gas mixtures, and dual fuel arrangements. Sizes and capacities to fit your needs.



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High-velocity type industrial space heating. Seven sizes. Capacities from 79,000 to 1,630,000 BTU per hour. Certified Ratings.

American Blower products serve industry

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- Mechanical Draft Equipment
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AMERICAN BLOWER

DROP FORGED STEEL

valves, fittings and flanges by Vogt

USED and TRUSTED by the NATIONS KEY INDUSTRIES

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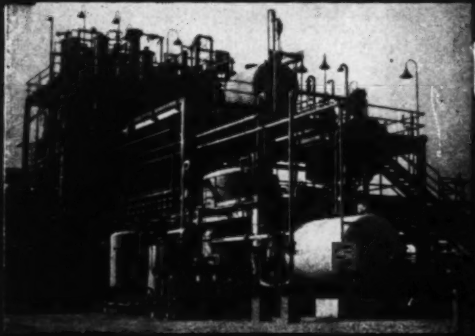


CHEMICAL PLANTS

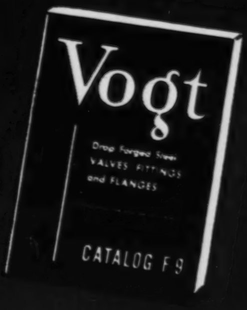
POWER PLANTS

There are good reasons behind [illegible] which America's key industries have [illegible] Vogt valves, fittings, and flanges for half a century. They know that *drop forged* [illegible] uniform in structure, fine grained, and free from porosity. They know, too, and appreciate the meticulous care given Vogt products through every stage [illegible] machining, to [illegible] about the many [illegible] inspections. And that is why these products enjoy such an impressive record of performance in withstanding the shocks and stresses imposed by high or low pressures and temperatures and in resistance to erosive and corrosive conditions.

Service is another important factor in this confidence because Vogt maintains the world's largest and most complete stock of drop forged steel valves, fittings, and flanges always ready for immediate shipment.

Write for Catalog F-9. Consult its 400 pages for the complete Vogt line of drop forged steel valves, fittings, and flanges for oil, steam, water, air, gas, and refrigeration services.

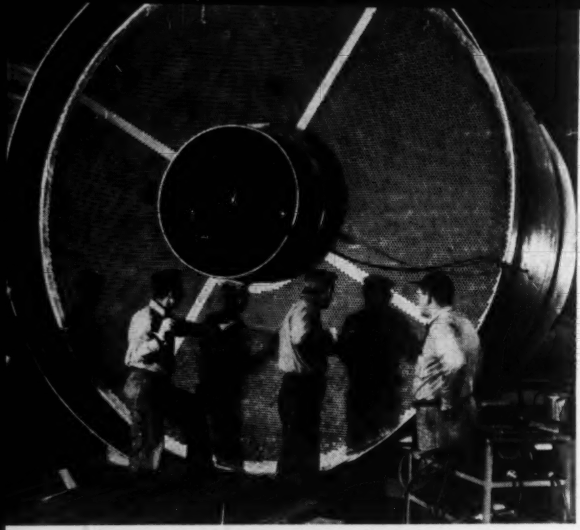
Address Dept. 24-F9



HENRY VOGT MACHINE CO. 75th Anniversary LOUISVILLE, KY.

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

SALES OFFICES: New York, Philadelphia, Chicago, Cleveland, Cincinnati,
St. Louis, Dallas, Charleston, W. Va., San Francisco



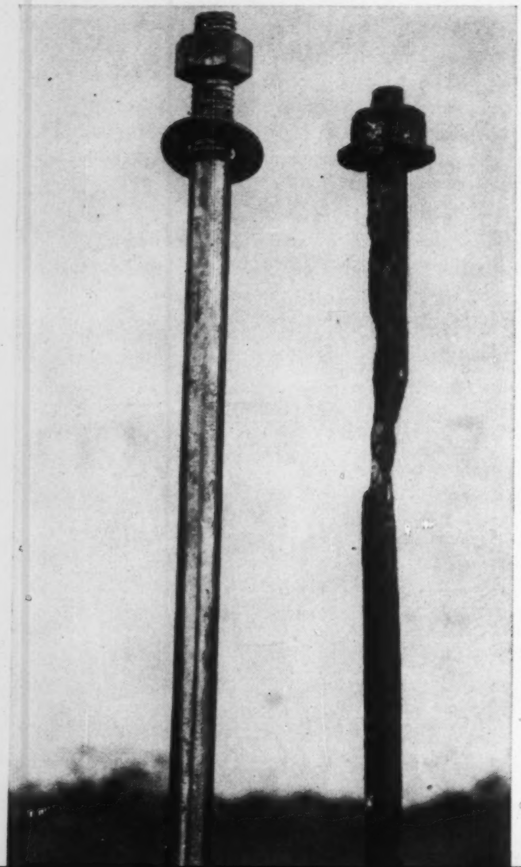
FOR HIGH TEMPERATURE STRENGTH. This looks like a sieve, but actually it is a Stainless Steel plate punched with 25,400 holes, and it makes up the end plate of a chemical plant heat exchanger. After the tubes were inserted the exchanger was placed in high-temperature, intensely corrosive 24-hour service. It was made by the Nooter Corporation, St. Louis.

NOTHING *can equal* *Stainless Steel*

for its combination of desirable properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers you the widest range of types, finishes and sizes.

FOR CORROSION RESISTANCE. Rare Earths, Inc., produces such valuables as cerium, lanthanum and praseodymium by means of an elaborate chemical separation process. In the filter press, corrosion destroyed carbon steel plate rods in six months. Stainless Steel rods were installed over six *years* ago, and are still in fine condition.



FOR TAKING A BEATING. These are 8th grade students from Dormont, Pa., public schools in a domestic science class. The sink tops were made by Pride Mfg. Co., Pittsburgh, from USS Stainless Steel. Says Pride, "These Stainless sink tops are ideal for school use. We've seen some 20-year-old sinks that still look as good as new."

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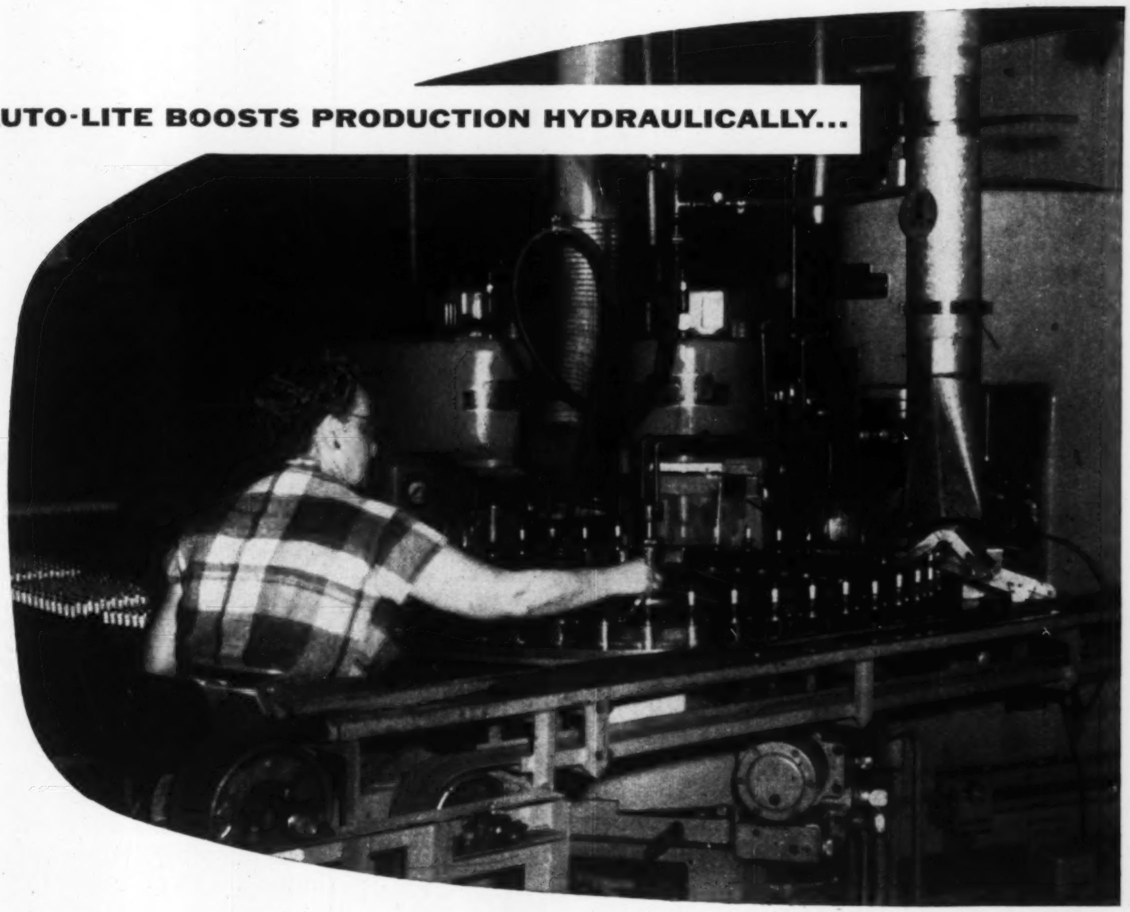
SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

AUTO-LITE BOOSTS PRODUCTION HYDRAULICALLY...



MULTIPRESS® installation automates assembly operations

- ★ **Sets new safety levels**
- ★ **Reduces tool and die costs, eliminates down-time**
- ★ **Improves product quality, provides for future expansion**

The installation of seven 48-station Multipresses at the Fostoria, Ohio, plant of Electric Auto-Lite has introduced added efficiency into a critical production stage — final assembly of spark plugs.

One unit with a single operator (1) pre-presses the top gasket of a spark plug to centralize the insulator within the shell; (2) cold forms the shell to anchor the entire sub-assembly as an integral unit; and (3) seals the shell and insulator. These operations had required *three individually operated presses.*

Since Multipress equipment was installed, materials handling has been reduced and tool and die costs cut substantially. Down-time has been virtually eliminated; maintenance can be carried on without interrupting production. Exact control over force application is now possible, with improved product quality control a direct result.

The experience of Auto-Lite is typical of hundreds of companies who have found that a Denison Multipress, with its automatically controlled hydraulic ram, can produce a better product . . . faster, more efficiently, and at less cost. Write for complete details.

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DENISON ENGINEERING COMPANY
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A Subsidiary of American Brake Shoe Co.

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

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Someday soon you may hear those words — have an opportunity to talk to our representatives in the privacy of your home.

There's an excellent reason why you should welcome such a call. It will give you an opportunity to ask questions about our attractive openings, our excellent wage rates and liberal employee benefit plans.

In work as demanding as aircraft engine development, there is tremendous challenge. Skills mature fast. Men of ability are soon recognized, encouraged and rewarded.

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If you are interested in a better future, mail the coupon *today*. If more convenient, send us a letter with the required information. Be sure to include your home telephone number.

Mr. E. M. Peterson, Dept. 8, Design Employment
Pratt & Whitney Aircraft, East Hartford, Conn.

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- ☐ Compressors
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- ☐ Structures
- ☐ Afterburners and Related Equipment
- ☐ Aerodynamics
- ☐ Hydraulics
- ☐ Gears
- ☐ Valves
- ☐ Heat Exchangers and Combustion Problems..........
- ☐ Bearings
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Total years Mechanical Design experience................

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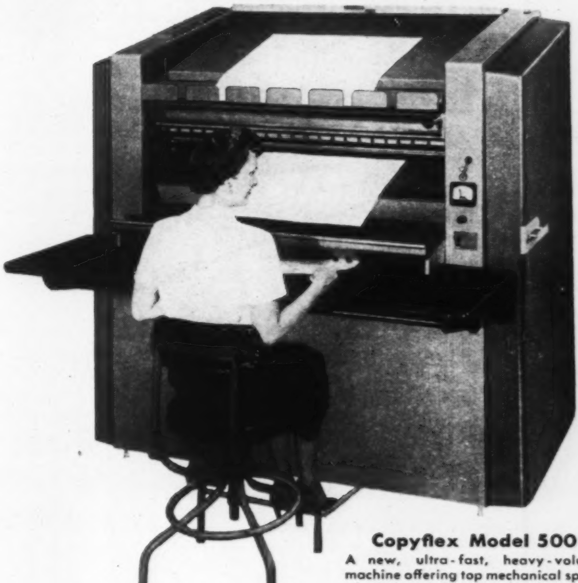
Pushed for Greater Drafting Room Output?
Modern Reproduction Machines Will Help You Get It!

NOW Is the Time to Get Your New, Modern
BRUNING COPYFLEX MACHINE!

The boom in production means more pressure than ever for engineering drawings and prints. Right now is the time to replace that old inadequate reproduction machine you've been putting up with — now's the time to get a modern, efficient Bruning Copyflex.

In just the last year, Bruning has introduced five new, advanced machine models, one of which is shown at the right. These machines offer you the famous problem-free installation and operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. They are the efficient, economical, modern reproduction machines that will help you boost your drafting room output, keep costs at a minimum.

Now is the time to act. Mail the coupon below. You'll be glad you did!



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A new, ultra-fast, heavy-volume machine offering top mechanical speed of 40 f.p.m., automatic separation, front or rear delivery, automatic stacking, and a host of other advanced features.

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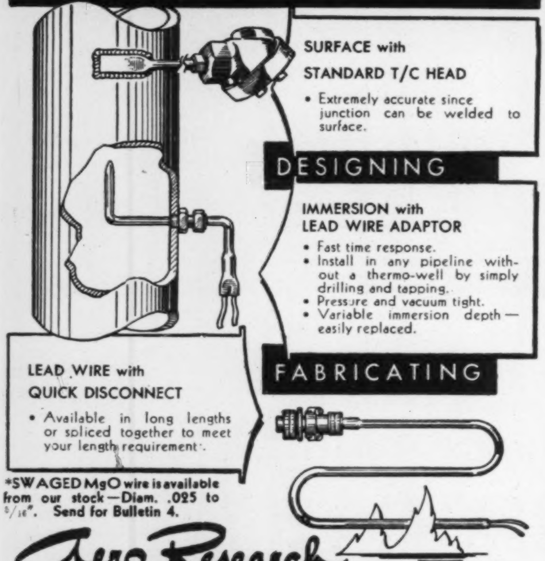
FOR OPERATING TEMPERATURES −300 to 2000°F

INSULATED THERMOCOUPLES



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- Extremely accurate since junction can be welded to surface.

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- Fast time response.
- Install in any pipeline without a thermo-well by simply drilling and tapping.
- Pressure and vacuum tight.
- Variable immersion depth—easily replaced.

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LEAD WIRE with QUICK DISCONNECT

- Available in long lengths or spliced together to meet your length requirements.

***SWAGED MgO wire is available from our stock—Diam. .025 to 5/16". Send for Bulletin 4.**

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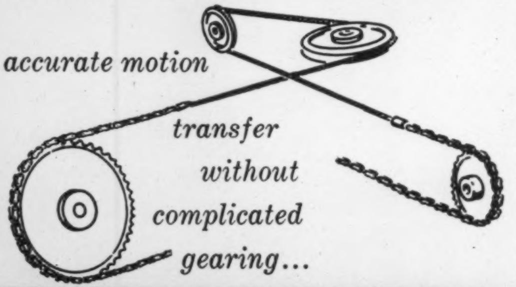

accurate motion transfer without complicated gearing...

SIERRA MINIATURE MECHANICAL CHAIN AND SPROCKETS...

Provide precise, positive motion transfer through several planes simultaneously with no cable slippage...no complicated gearing. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, electronic equipment, and small precision instruments. Less weight, cost, maintenance—wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials, including non-magnetic beryllium copper.

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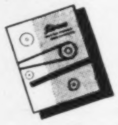

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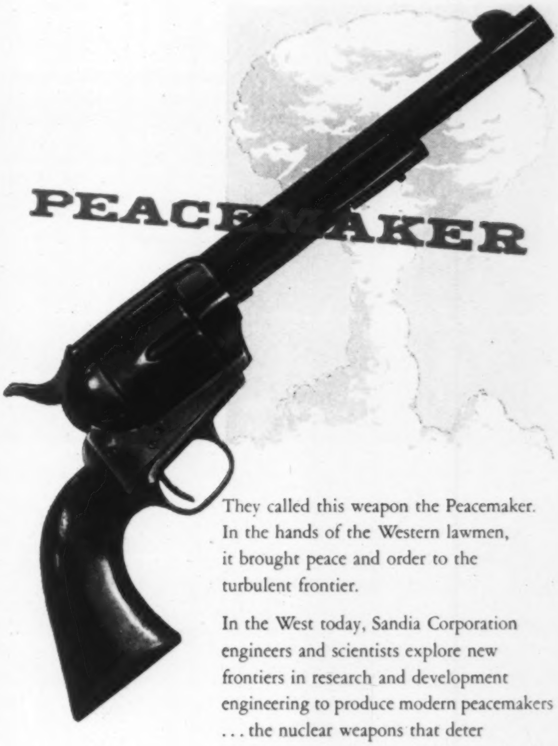

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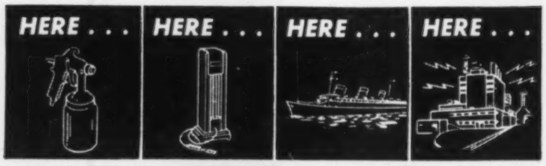

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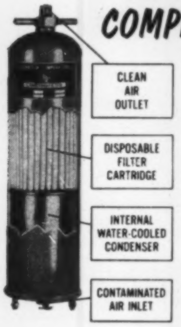

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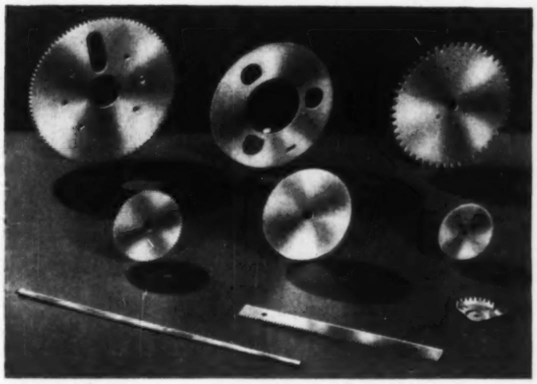

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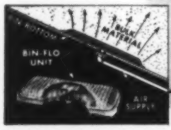

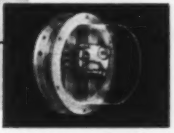

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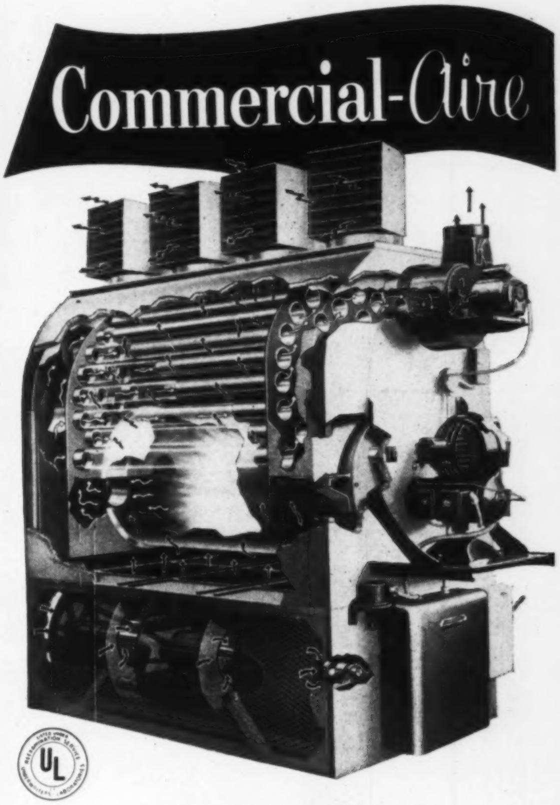

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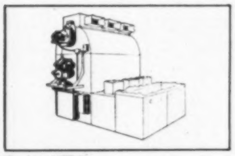

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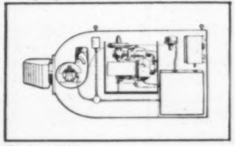

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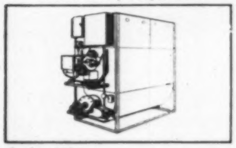

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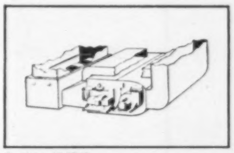

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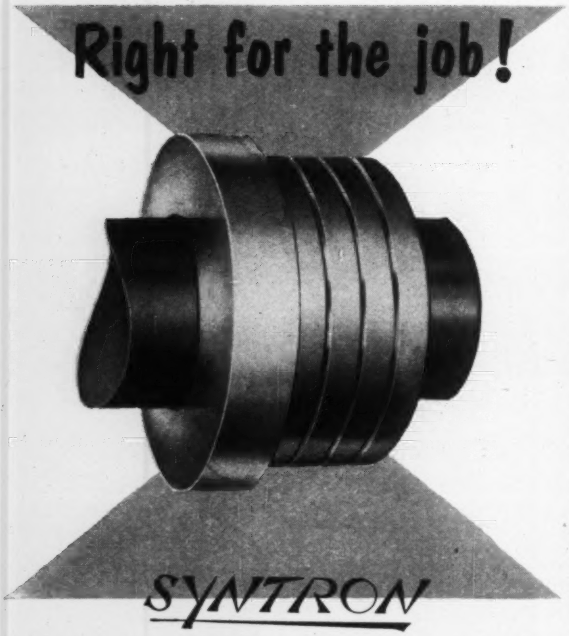

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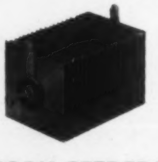

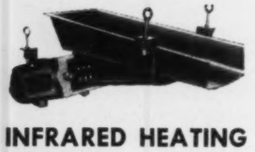

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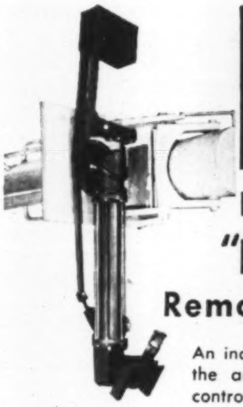

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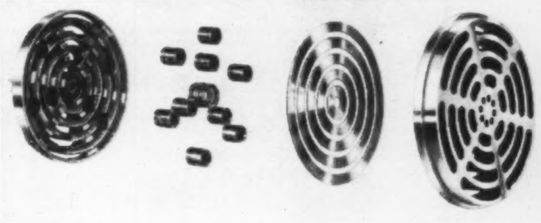

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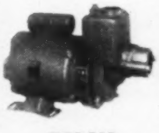

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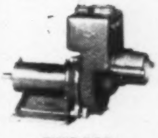

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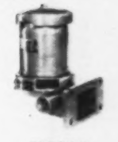

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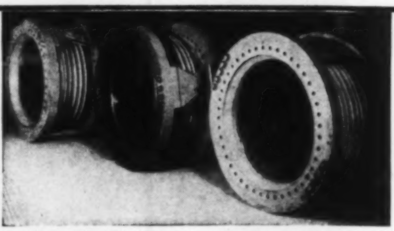

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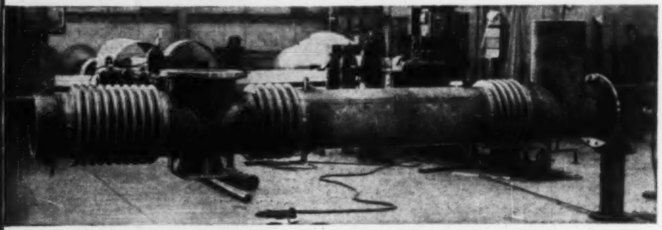

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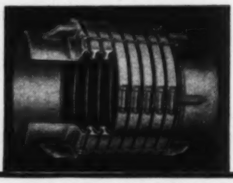

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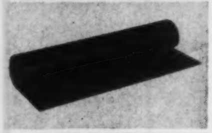

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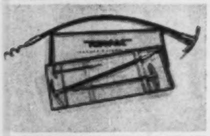

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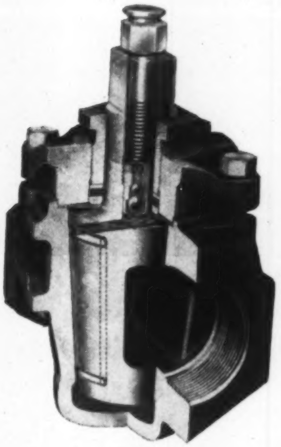

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Supersonic jet inlet: an example of Boeing-Wichita research

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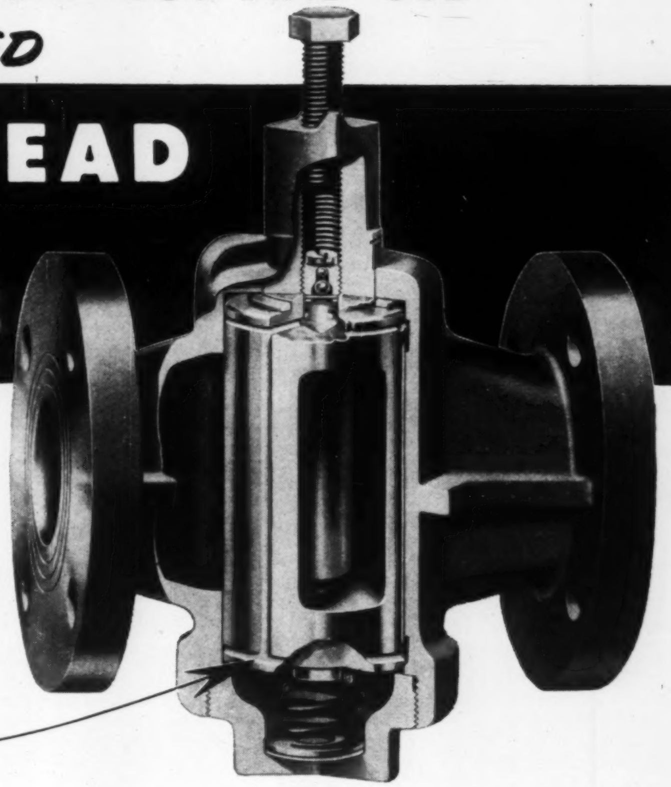

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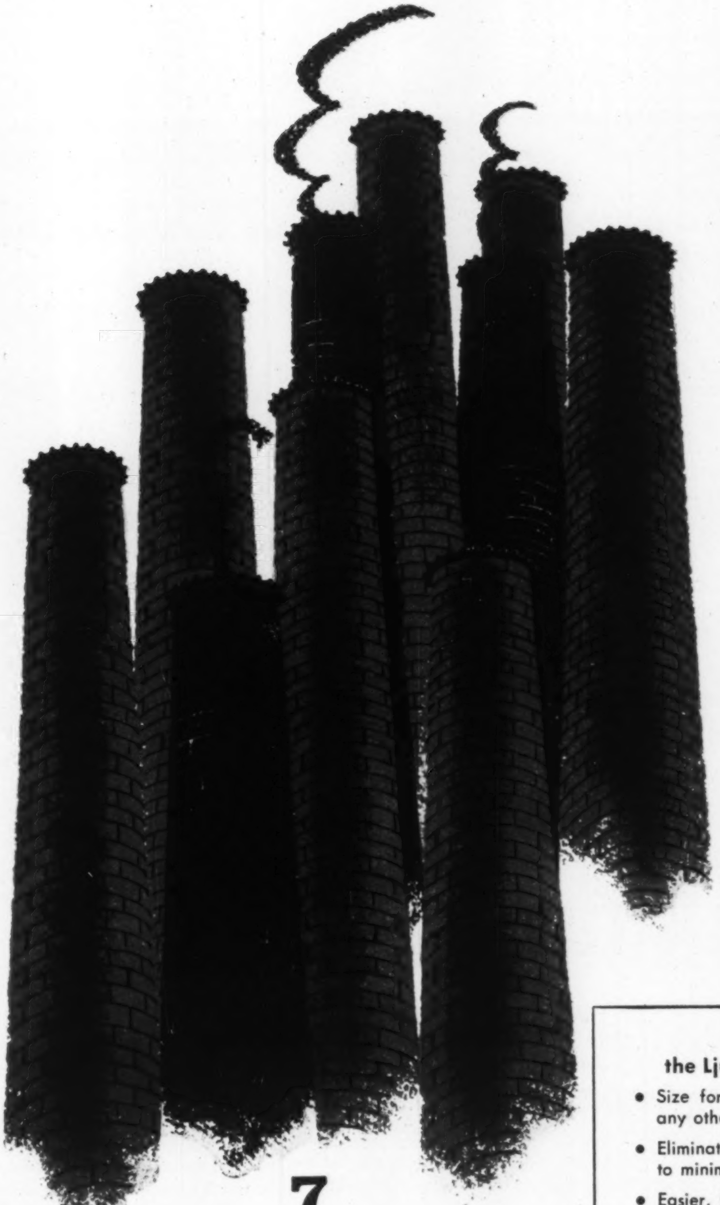

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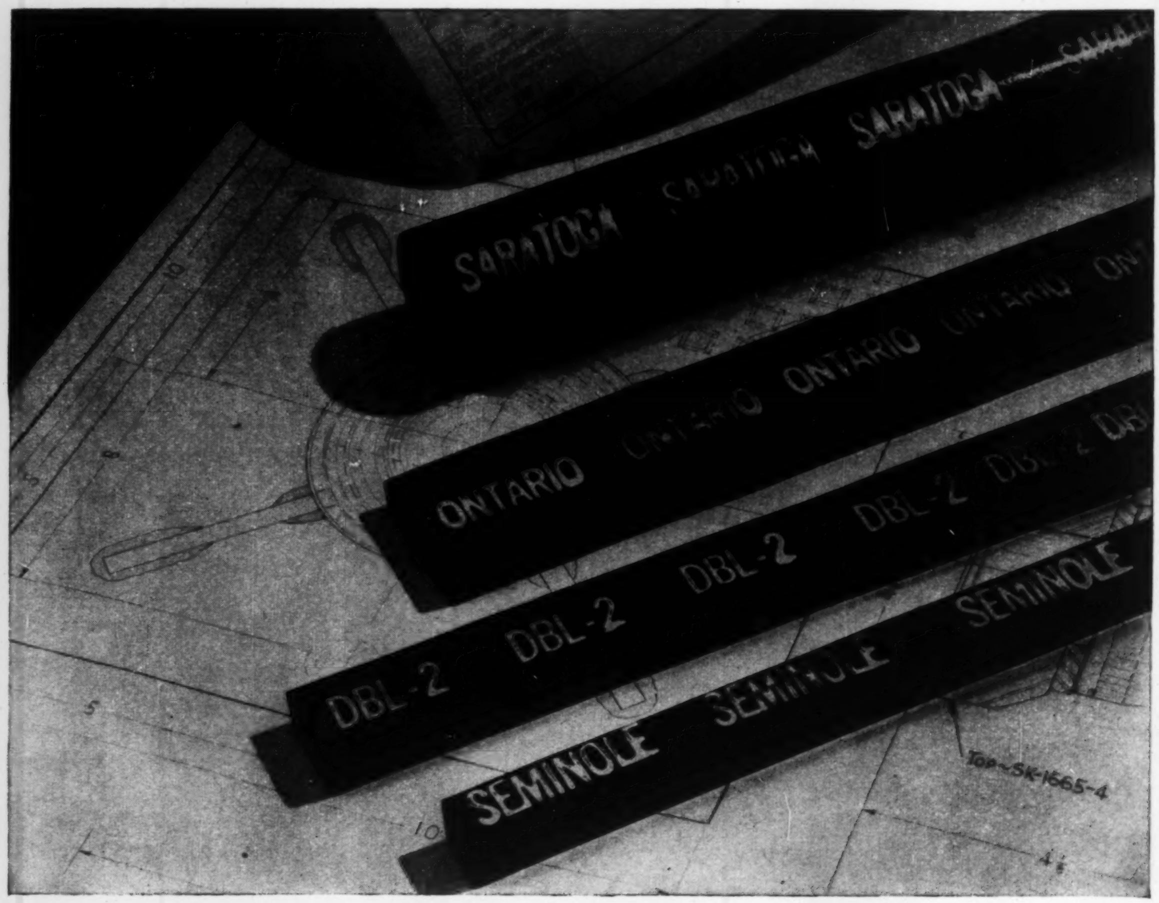

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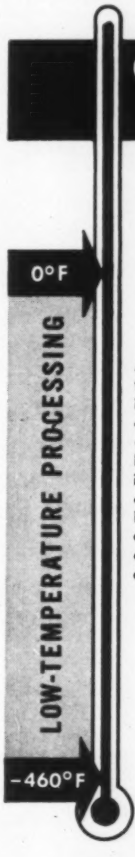

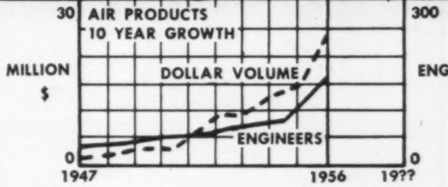

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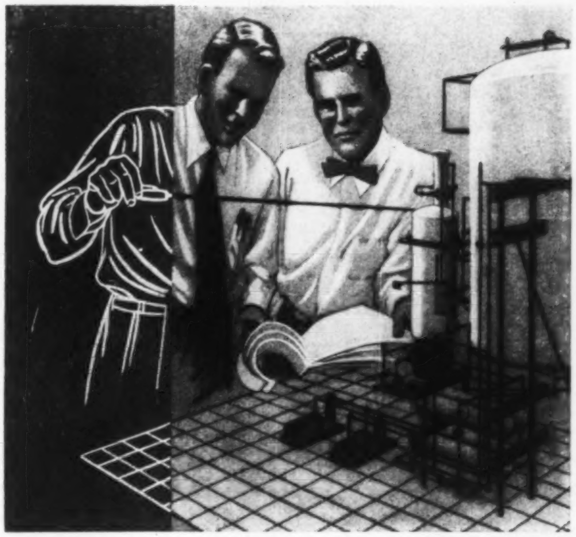

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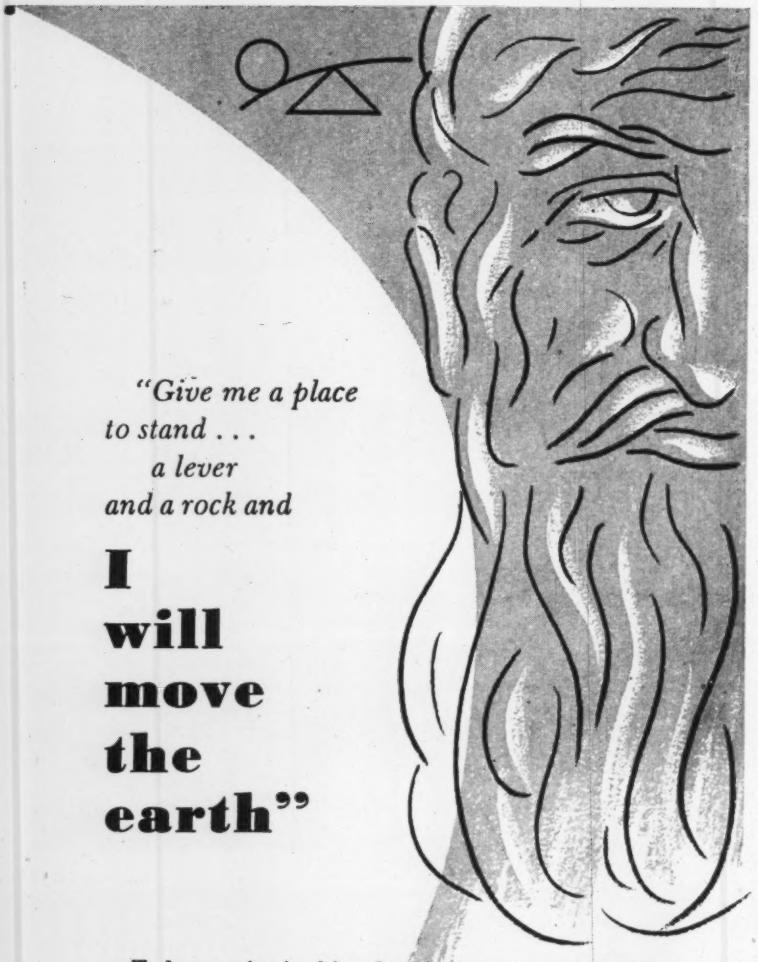

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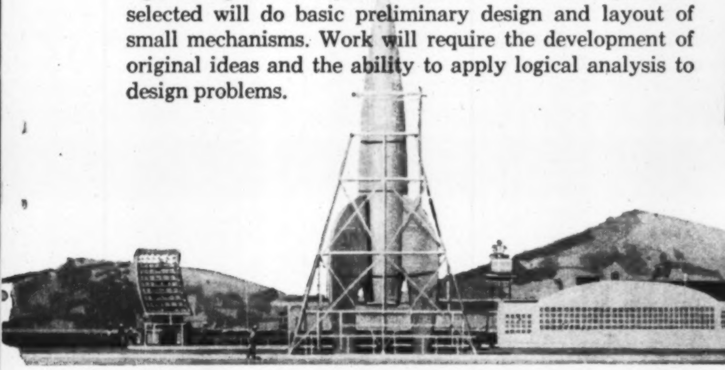

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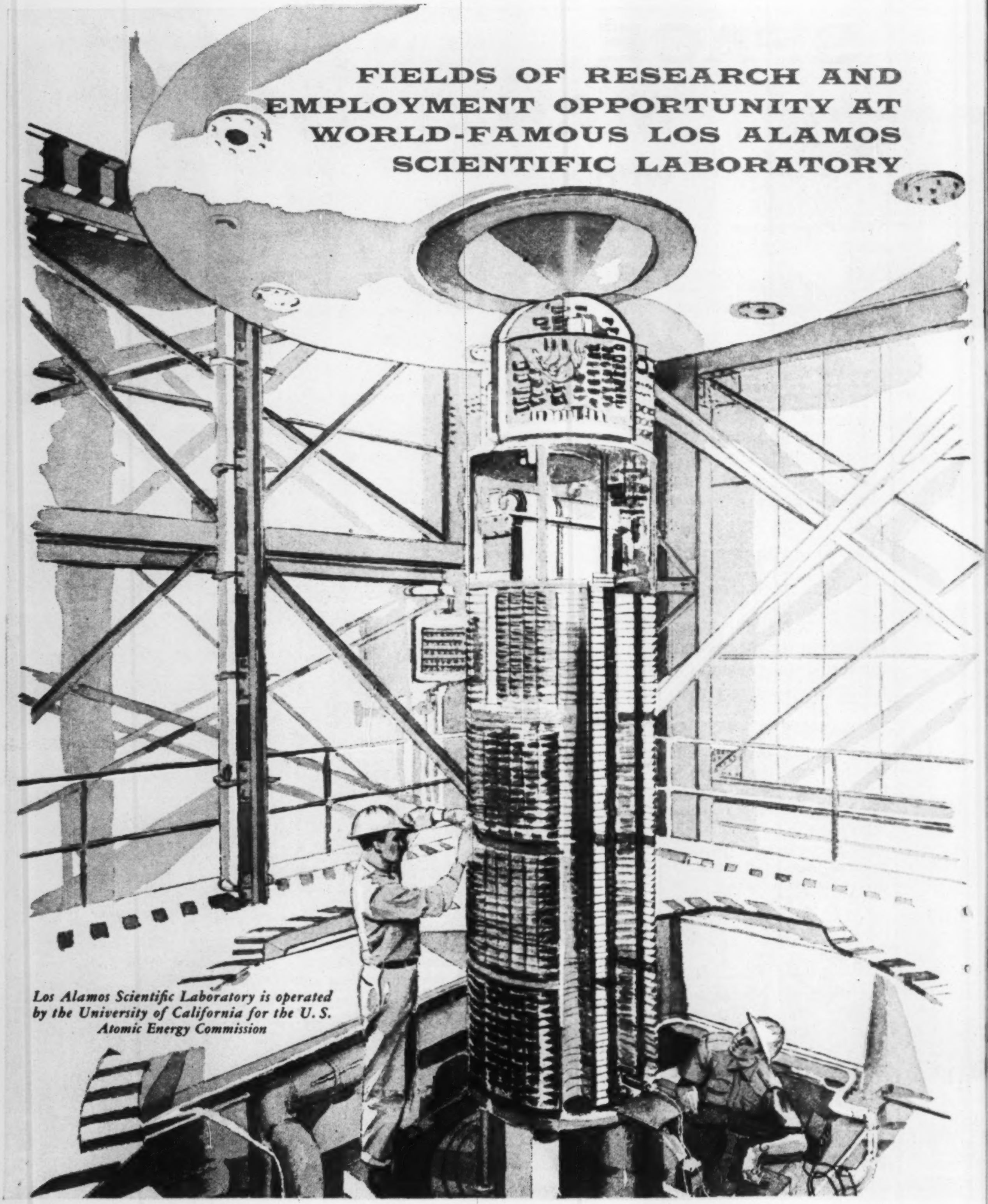

Los Alamos Scientific Laboratory is operated by the University of California for the U. S. Atomic Energy Commission

Theoretical Physics and Mathematics

In the field of theoretical physics, the Laboratory carries on studies of nuclear theory, equations of state, mathematical analysis methods, hydrodynamics problems and various aspects of applied mathematics. The Theoretical Division is also concerned with the conceptual design of nuclear weapons, and supports many non-weapons activities such as the nuclear reactor and propulsion programs. The equipment used includes the Los Alamos-developed Maniac, the Maniac II, two IBM 704's and an IBM 701.

Experimental Nuclear Physics

Much of the work in experimental physics is concerned with nuclear properties of various materials. Fundamental studies are made of nuclear forces, neutron and charged-particle reactions and cross sections. Experimentation in controlled thermonuclear reactions is assuming increasing importance. Among the facilities available are three Van de Graaffs, two Cockcroft-Walton machines and a variable energy cyclotron.

Electronics and Instrumentation

The Laboratory is engaged in the design and development of nuclear physics research instruments, scintillation counters, fast pulse amplifiers, multi-channel analyzers, fast oscilloscopes, radiation detection instruments, electronic controls and control systems, and high-speed cameras which operate at 15 million frames per second. Electronics specialists also assist in the design of digital computers and of instruments for studying nuclear and thermonuclear detonations.

Nuclear Reactor Research

In connection with the peacetime applications of nuclear energy, the Laboratory is currently developing several advanced power reactors of unusual design. In addition, two research reactors are available for experimental studies. The remotely controlled critical assembly machines, known as Topsy, Godiva and Jezebel, constitute neutron research tools of a unique character.

Nuclear Propulsion

The Laboratory is actively engaged in the application of nuclear energy to the new and challenging field of self-propelled mobile reactors. There are studies in progress relative to engine design, heat transfer, controls and instrumentation.

Chemistry

Research in chemistry is devoted largely to inorganic and physical studies, especially of materials such as uranium, plutonium, deuterium and tritium used in nuclear energy systems. Radiochemical methods are applied in various investigations. Much work is being done on reaction kinetics, the effects of radiation on chemical reactions, complex ion formation and the determination of heats of combustion and solution. Extensive analytical studies include the use of a great variety of instruments, as well as the techniques of microanalysis.

Metallurgy and Metallurgical Engineering

Research activity and development in this field includes investigation of the metallurgical properties of materials used in nuclear energy systems; studies of extremely refractory substances, ceramics, cermets and plastics; the behavior of materials under extremely high temperatures and high pressures; studies of the properties of plutonium and its alloys, with increasing reference to their use in reactors, and of uranium and its alloys; development of fabrication techniques for various metals and alloys; and the high temperature properties of refractory metals tungsten, molybdenum, columbium, etc.

Weapons Physics, Design and Testing

Still the nation's principal institution for nuclear and thermonuclear weapons research, the Laboratory takes nuclear weapons from the concept stage to proved performance as determined by field tests. Activities in weapons research and development include the mechanics and dynamics of initiating a nuclear energy release; the behavior of supercritical systems; the testing of nuclear devices and weapons assemblies in Nevada and in the Pacific; engineering design of tests and prototypes of nuclear systems; and the design and development of nuclear weapons components and the techniques for their manufacture.

Explosives Research and Development

Work in this field includes study of fabrication, storage and stability problems of explosives; making and evaluating novel organic chemical compounds of possible use as explosives; mechanics and dynamics of explosive phenomena; and physical and chemical properties of explosive material using mass spectrometer, infra-red spectrometer, X-ray equipment and other analytical techniques. High explosives are employed in research on equations of state and shock wave phenomena.

Mechanical Engineering

Design and development work is carried on in connection with weapons design, field test facilities, the power reactor and propulsion programs, servo-mechanisms and remote control systems. High explosives systems are designed and manufactured. Other types of work are estimating, cost analysis and liaison between architectural engineers and contractors.

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Chemical engineering work includes studies of heat transfer, fluid flow, solvent extraction, evaporation, distillation and systems at extreme temperatures and pressures. Problems supporting inorganic and physical chemistry research projects are also undertaken. Other activities are the remote control handling of radioactive materials and corrosion and erosion studies.

Electrical Engineering

Much effort is devoted to the design of induction heating systems for study of alloys at extremely high temperatures; of DC power supplies at currents up to 100,000 amperes; of servomechanism controls for nuclear reactors; and of high magnetic field systems. Work is done in planning, building and installing power distribution systems and their controls.

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Division 1107

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ENGINEERS

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offers unusual growth opportunities to engineers

Two years ago, world attention centered on Electric Boat at Groton, Connecticut where scientific boldness harnessed the power of atomic energy to launch the Nautilus, which will soon be followed by its sister ship, Seawolf. Next to glide down the ways will be even more powerful versions . . . a third, fourth and fifth nuclear powered craft.

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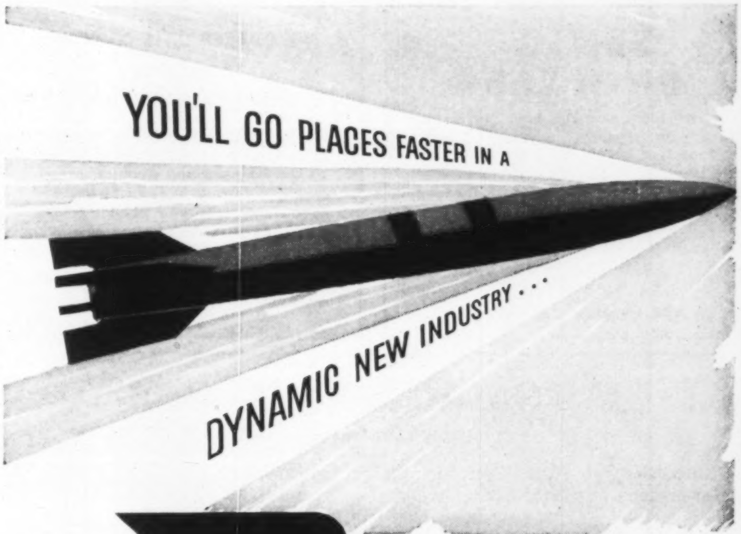
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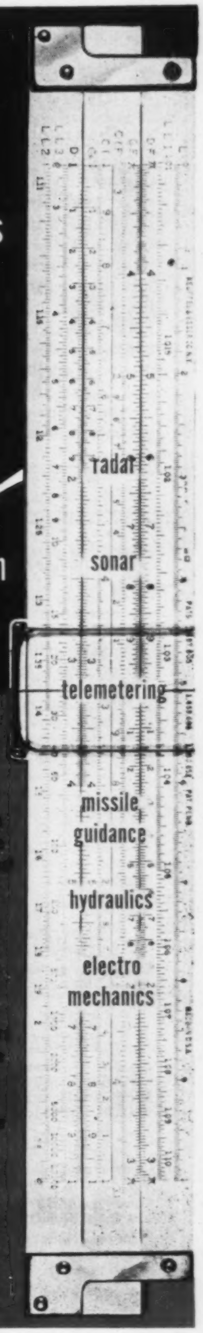

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Continued from page 148

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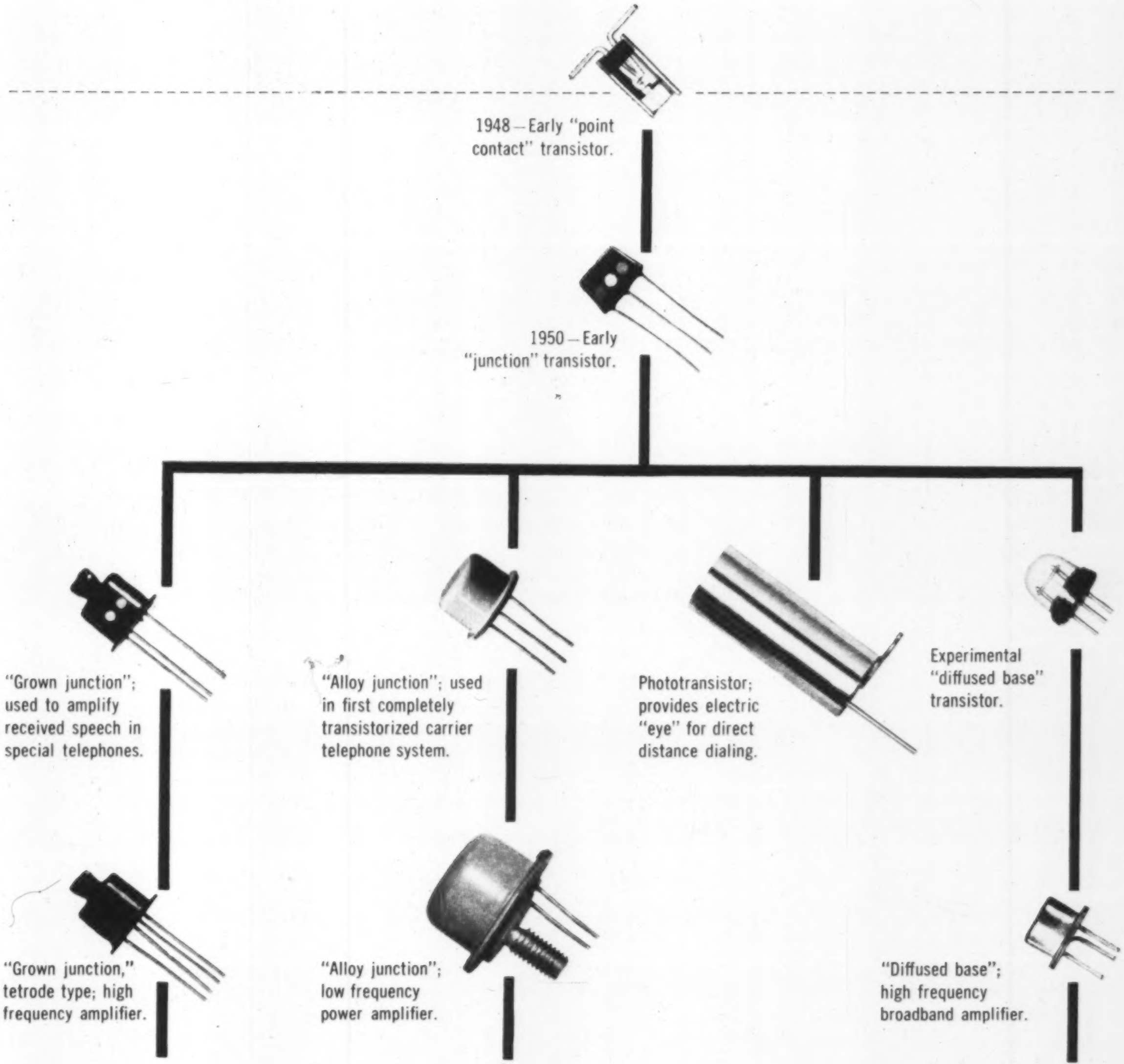
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OIC VALVES

FORGED & CAST STEEL, LUBRICATED
PLUG, BRONZE & IRON VALVES

New heavy-duty precision lathe mounts spindle on TIMKEN® bearings for maximum rigidity thru 12-speed range

THE new Atlas-Clausing 5300 has new massive headstock and tailstock, heavy-duty bed and carriage for rigidity and stamina. The spindle bearings must have high precision, must maintain that precision at all speeds, under heavy loads. That's why Atlas-Clausing chooses Timken® precision bearings.

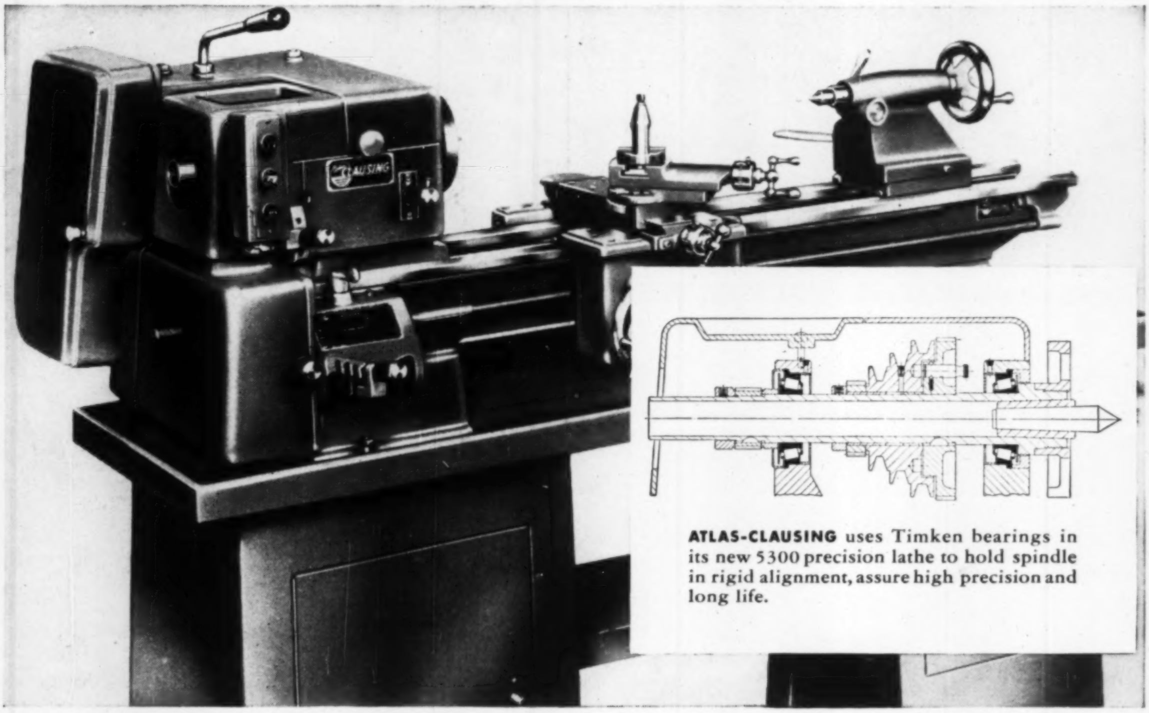
Timken bearings, because of their tapered design, take radial and thrust loads in any combination, hold spindle in rigid alignment. There is no end play. Timken bearings assure precision at all times.

The extra load-carrying capacity of Timken bearings comes from the full line contact between the rollers and races. And, since Timken bearings are built to last the life of the lathe itself, maintenance costs go down.

Timken bearings save power because they practically eliminate friction. They are geometrically designed to give true rolling motion, precision manufactured to live up to their design. And to make sure we get steel good enough for Timken bearings, we make it ourselves. No other U. S. bearing maker takes this extra step to insure quality in every bearing.

You can get all the advantages of Timken bearings only by specifying Timken bearings in all the equipment you build or buy. Look for the "TIMKEN" trade-mark on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



ATLAS-CLAUSING uses Timken bearings in its new 5300 precision lathe to hold spindle in rigid alignment, assure high precision and long life.

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

$$Value = \frac{quality + service + public\ acceptance}{price}$$

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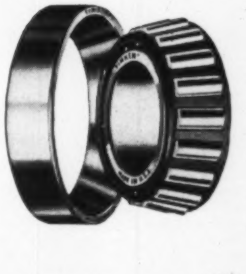

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